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SNAKE RIVER BIRDS OF PREY RESEARCH PROJECT

ANNUAL REPORT

1988

Karen Steenhof
Editor

NOT FOR PUBLICATION

The data presented herein are preliminary and may be inconclusive. Permission to publish or cite any of these materials is therefore withheld pending specific authorization of the Boise District, BLM, and the specific Principal Investigator.

Michael N. Kochert
Research Leader

J. David Brunner
Boise District Manager

Delmar Vail
Idaho State Director

PREFACE

This report summarizes research and monitoring activities in the Snake River Birds of Prey Area during calendar year 1988.

Two new graduate studies were initiated in the area by students from Boise State University. Helen Ulmschneider began an investigation of long-eared owl post-fledging activity, and Dawn McAnnis started a study on ferruginous hawk habitat use. The ferruginous hawk study was supported jointly by Boise State University and the Bureau of Land Management, and funds for the effort were made available by a grant from the Idaho State Board of Education for studies of the "Effects of Fire-altered Habitat on Raptor Populations." The grant also provided funds for studies of the effects of fire on soil microbial communities by Marcia Wicklow-Howard and Robert Rychert.

The 2 cooperative studies with Pacific Power and Light Company and the 1 with Idaho Power Company and Pacific Gas and Electric continued in 1988. This was the final year for the IPC/PGE cooperative study on prairie falcons, and all work focused on analysis and writing of reports. The PP&L raven roosting study also entered a write-up phase with only a limited amount of monitoring fieldwork. The PP&L nesting study continued at the same levels as in past years.

Other 1988 field activities included continuing investigations of common barn-owl feeding ecology by Dr. Carl Marti of Weber State College, assessment of nest box use by American kestrels by Karen Steenhof (BLM) and Craig Groves (Idaho Department of Fish and Game), and studies of western screech-owl and northern saw-whet owls using nest boxes in the SRBOPA by Jeff Marks and John Doremus (Bruneau Resource Area).

Monitoring of raptor nesting populations continued in 1988. Bruneau Resource Area personnel assessed nesting densities of red-tailed hawks and prairie falcons in selected portions of the SRBOPA, and research staff personnel determined occupancy and productivity of golden eagles and ferruginous hawks.

Monitoring of prey and vegetation continued in 1988. Kris Timmerman joined the research staff as a Biological Technician and supervised continued investigations of Townsend's ground squirrels. Monitoring of black-tailed jack rabbits and kangaroo rats by Bruneau Resource Area staff continued as in past years, and additional spotlighting transects were established within the Orchard Training Area with the assistance of Idaho Army National Guard personnel. Vegetation on transects in 8-year old burns was sampled, and 5 years of data were analyzed. Funds for prey and vegetation monitoring were provided, in part from a grant from the Idaho State Board of Education to Boise State University.

Technology transfer continued to be a priority for the Research Project. Sixteen scientific papers were published and/or accepted for publication in 1988, and Birds of Prey Research Project staff members and associates made 10 technical presentations at meetings.

In 1988, the BLM Research staff, in consultation with the Idaho Army National Guard, developed a draft research plan to investigate the effects of habitat alteration on the raptors, their prey, and their habitat in the SRBOPA. Wildfire and National Guard activities are the 2 main activities that will be addressed by the proposed research. Research questions were identified in April 1988, and 2 workshops (1 in August and 1 in November) were held to recommend overall approaches.

Karen Steenhof and Mike Kochert collaborated with Dr. Tom Cade of Boise State University in submitting a proposal to the Idaho State Board of Education for research on validating prairie falcon monitoring techniques.

Results of the research, study, and monitoring efforts from the 1988 field season are presented in this report.

ACKNOWLEDGMENTS

The Bureau of Land Management wishes to thank those agencies and individuals who assisted with the project. Appreciation is extended to the Idaho Department of Fish and Game and the U.S. Fish and Wildlife Service for special permits and assistance. Special thanks go to all other individuals who volunteered their services.

COOPERATING AGENCIES AND INSTITUTIONS

Boise State University
College of Idaho
Idaho Army National Guard
Idaho Department of Fish and Game
Idaho Department of Transportation
Idaho Department of Water Resources
Idaho Power Company
Idaho State University
Pacific Gas & Electric Company
Pacific Power and Light Company
University of Idaho
University of Wisconsin
U.S. Fish and Wildlife Service
U.S. Forest Service Intermountain Research Station
Weber State College
World Center for Birds of Prey

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* Published and/or accepted for publication in 1988. Reprints of most of these articles are available from the Birds of Prey Research Project, Boise District, BLM, 3948 Development Avenue, Boise, ID 83709.

1988 Birds of Prey Research Technical Presentations

2/26/88 Kochert, M.N. Effects of livestock grazing on raptors in the western United States. Annual meeting of the Idaho Chapter of the Wildlife Society. Boise, Idaho.

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2/27/88 Holthuijzen, A.M.A., A.R. Ansell, M.N. Kochert, L.S. Young, and K. Steenhof. Prey delivery rates of nesting prairie falcons. Annual meeting of the Idaho Chapter of the Wildlife Society. Boise, Idaho.

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10/19/88 Kochert, M.N. Research in the Snake River Birds of Prey Area. Presentation to the Purdue Chapter of The Wildlife Society, West Lafayette, Indiana.

11/10/88 Kochert, M.N. Research in the Snake River Birds of Prey Area. Presentation to the Boise Chapter of the Sierra Club.

PART II

PROGRESS REPORTS

TITLE: Nesting Density and Productivity of Golden Eagles and Ferruginous Hawks in and near the Snake River Birds of Prey Area.

INVESTIGATORS: Karen Steenhof, Associate Research Leader
Michael N. Kochert, Research Leader

OBJECTIVES:

1. To determine occupancy, nesting success, and productivity at traditional golden eagle (*Aquila chrysaetos*) and ferruginous hawk (*Buteo regalis*) nesting territories.

2. To compare occupancy and productivity of golden eagle pairs in the Birds of Prey Area (SRBOPA) with those of eagle pairs in the Comparison Area.

3. To continue to record movements of banded and wing-marked raptors and ravens.

ANNUAL SUMMARY

The number of occupied golden eagle territories in the SRBOPA was the same as in 1987, and percent of eagle pairs breeding was similar. Percent nesting success was the highest observed since 1984, but overall productivity, although higher than in the past 3 years, was still below pre-1984 levels. As in the past 2 years, eagle productivity was lower in the SRBOPA than in the Comparison Area. Ferruginous hawk productivity in the SRBOPA was relatively high as in past years.

METHODS

Golden eagle territories in the SRBOPA and Comparison Area (Fig. 1) were surveyed for occupancy from a Hiller/Soloy jet helicopter on 16 March. Some territories on or near the Pacific Power Co. (PP&L) 500 kV transmission power line were also checked from a Hughes 500D on 7 April and from a Hiller/Soloy on 4 May. Territories where breeding status could not be determined during the March helicopter flight were subsequently surveyed from the ground for signs of occupancy or breeding (see below for criteria). Territories containing breeding pairs were checked for productivity from a Bell 206B Jet Ranger on 7 and 16 June.

We attempted to ascertain the breeding status and nesting success of all eagle and ferruginous hawk pairs located prior to hatching. Additional information on reproduction was obtained from other pairs found later in the season. We climbed to 1 golden eagle to band young, and ferruginous hawk nests were also monitored by the investigators from the cooperative BSU study on fire effects. Eagle pairs that showed no evidence of egg laying after repeated observations or after climbing into and examining potential nests were categorized as "nonbreeding." A "breeding attempt" was confirmed if an occupied territory contained an incubating adult, eggs, young, or any other

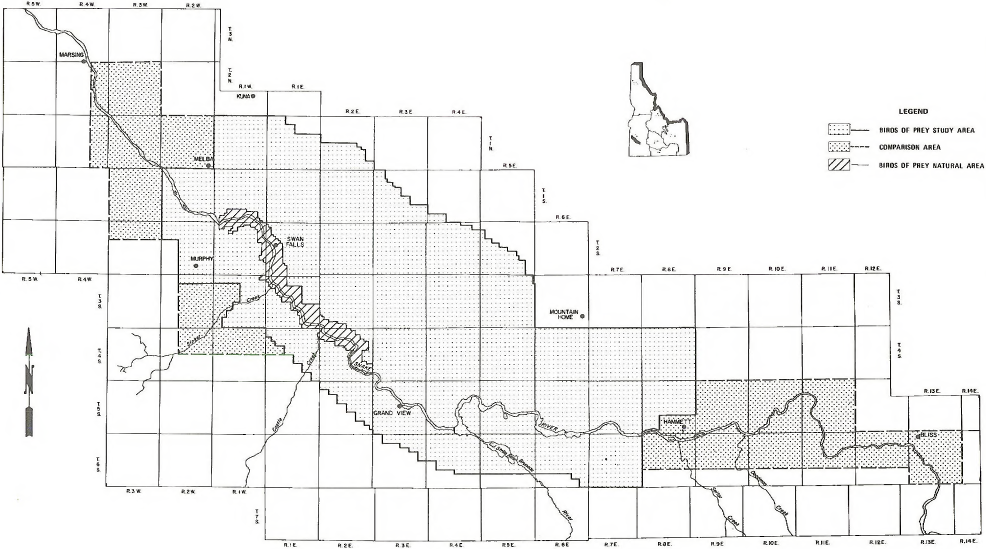

Fig. 1. LOCATION OF THE BIRDS OF PREY STUDY AREA (BPSA) AND COMPARISON AREA

indication that eggs were laid (e.g., fresh eggshell fragments in fresh nesting material). A breeding attempt was "successful" it produced 1 or more young that reached fledging age (i.e., 51 days for golden eagles and 33 days for ferruginous hawks (Steenhof 1987)). Eagle nests discovered after young had fledged were considered successful if: 1) a platform decorated this season was worn flat and contained fresh prey remains, 2) fresh fecal matter covered the back and extended over the edge of the nest, and 3) no dead young birds were found within a 50-m radius of the nest.

Percent of pairs breeding in 1988 and earlier years was calculated from preselected pairs (Steenhof and Kochert 1982). Percent of nesting attempts successful was based on attempts found during incubation. Nests that were manipulated by fostering, disease treatment, shade devices, etc. were excluded from productivity calculations.

RESULTS

Nesting Density

In 1988 golden eagle pairs occupied 31 (84%) of the 37 traditional eagle nesting territories in the SRBOPA. In addition, a pair established a new territory at Mile 125 of the PP&L line within the SRBOPA. The total number of occupied territories in the SRBOPA was unchanged from 1987 (Table 1). Six territories were confirmed to be vacant; of these, only 2 (Upper Sinker and Pump Station) were known to have been occupied in 1987. Two territories in the Comparison Area (Hammett GN and Malad) were confirmed to be vacant in 1988.

At least 26 pairs of ferruginous hawks occupied nesting territories in the SRBOPA in 1988. These included 1 pair (AFB Gunnery Range) that occupied a territory not known to have been occupied in previous years. Three traditional sites within the SRBOPA (Massacre Draw, Spring Draw, and Strike II) were confirmed to be vacant and several were not surveyed, so it is likely that more than 26 ferruginous hawk pairs nested in the SRBOPA.

Reproduction

Golden eagle reproduction in the SRBOPA increased from 1987 levels (Table 1). Percent of pairs breeding decreased from 78% in 1987 to 74% in 1988, but percent of attempts successful increased from 32% in 1987 to 55% in 1988. Young fledged per pair increased from 0.34 in 1987 to 0.63 in 1988 (Table 1). The increase in percent of attempts successful and number of young fledged per successful attempt suggests that nestling mortality was much lower than in 1987. As in the past 4 years, golden eagle reproduction was higher in the Comparison Area than in the SRBOPA (Table 2). Number of young eagles raised per pair in the Comparison Area increased from 0.47 in 1987 to 0.99 in 1988. Ninety percent of eagle pairs in the Comparison Area laid eggs, and a higher percent of attempts were successful in the Comparison Area (75%) than in the SRBOPA (55%). Throughout the southwestern Idaho study area, canyon nesters fared better than powerline nesters in 1988 (0.83 and 0.40 young fledged per pair, respectively; Table 2).

Table 1. Nesting success and productivity of golden eagles in the BOPA, 1971-1988. Sample sizes are in parentheses.

Year	# of Nesting Pairs	% of Pairs Breeding	% of Attempts Successful	# Fledged/ Successful Attempt	# Fledged Per Pair	Total # Fledged
1971	34	100% (31)	60% (20)	1.89 (19)	1.13	39
1972	34	--	--	1.64 (11)	--	--
1973	35	65% (34)	44% (18)	1.37 (8)	0.39	14
1974	35	73% (30)	56% (18)	1.42 (12)	0.58	20
1975	33	75% (32)	56% (18)	1.43 (14)	0.60	20
1976	35	70% (33)	47% (15)	1.62 (13)	0.53	19
1977	34	82% (33)	59% (17)	1.53 (15)	0.74	25
1978	32	80% (30)	70% (10)	1.71 (17)	0.96	31
1979	30	97% (30)	61% (23)	1.53 (19)	0.91	27
1980	31	87% (31)	72% (18)	1.77 (22)	1.11	34
1981	30	100% (30)	74% (23)	1.73 (22)	1.28	38
1982	30	87% (30)	80% (25)	1.95 (19)	1.36	41
1983	28	96% (27)	72% (18)	1.56 (16)	1.07	30
1984	31	--	61% (18)	1.55 (11)	--	--
1985	32	39% (31)	42% (12)	1.00 (4)	0.16	5
1986	29	54% (28)	29% (14)	1.33 (6)	0.21	6
1987	32	78% (32)	32% (25)	1.38 (8)	0.34	11
1988	32	74% (31)	55% (22)	1.54 (13)	0.63	20

Table 2. Nesting success and productivity of golden eagles in southwestern Idaho, 1988. Sample sizes are in parentheses.

Study Area	% of Pairs Breeding	% of Attempts Successful	# Fledged/ Succ. Attempt	# Fledged Per Pair
BOPA*	74% (31)	55% (22)	1.54 (13)	0.63
Comparison	90% (21)	75% (20)	1.47 (17)	0.99
PP&L 500 kV	60% (5)	67% (3)	1.00 (2)	0.40
Canyon **	84% (50)	64% (39)	1.54 (28)	0.83

* includes the pairs at PP&L 119 and 125.

** includes all cliff nests in the BOPA and Comparison Area.

Of 16 ferruginous hawk pairs found during incubation, 15 (94%) were successful, and successful pairs fledged an average of 3.00 young (Table 3). Six of the nests we surveyed for reproduction in 1988 were on the 500 kV transmission line, 3 were on other power lines, 3 were on artificial platforms (Howard and Hilliard 1980), and only 4 were on cliffs. Because natural substrate nests generally have lower success rates (PP&L Nesting Annual Report, this volume), our productivity estimates for the SRBOPA may be inflated.

Banding and Marking

During 1988, 141 raptors were banded with aluminum U.S. Fish and Wildlife Service bands under the BLM Master Station Banding Permit. This included 1 golden eagle, 1 prairie falcon, 29 ferruginous hawks, 48 American kestrels (*Falco sparverius*), 23 western screech-owls (*Otus kennicottii*), and 39 long-eared owls (*Asio otus*). Both nestling and adult raptors were banded. The screech-owls were banded as part of the screech-owl study, the long-eared owls were banded as part of a BSU graduate study on long-eared owl post-fledging ecology, the kestrels were banded as part of the kestrel nest box study, and ferruginous hawks were banded as part of a cooperative study with BSU on fire effects (see progress reports for each of these studies in this volume). The prairie falcon was captured incidental to the ferruginous hawk trapping. Eleven long-eared owls and 4 ferruginous hawks were fitted with radio transmitters. Three of the radioed hawks were fitted with patagial wing markers, and 10 of the radioed owls were banded with colored leg bands.

Band Recoveries and Sightings of Marked Birds

In 1988 we received reports of band recoveries for 1 golden eagle and 2 ferruginous hawks. The golden eagle band was found in the Crater Rings, near Mountain Home, Idaho and was from a 1987 nestling that apparently never dispersed from its natal territory. The 2 ferruginous hawks recovered were siblings from the 1987 Old Beacon Inn nest. One was found dead in October 1987, near Colton, California. The other was found entangled in a fence in June 1988 south of Mountain Home, only a few kilometers from its natal nest. During golden eagle nesting surveys we observed a wing-marked adult golden eagle on the Walters Butte territory. The yellow/blue bicolor marker on the right wing indicated the bird was marked as a nestling in 1980.

ACKNOWLEDGMENTS

Pacific Power Company is acknowledged for providing flight time to conduct the eagle helicopter surveys. J. Skinner assisted with golden eagle surveys. We thank R. Holman, Idaho Department of Fish and Game Region IV, for making observations at eagle nests in the Comparison Area.

Table 3. Nesting success and productivity of ferruginous hawks in the BOPA, 1976-1988. Sample sizes are in parentheses.

Year	# of Nesting Pairs	% of Pairs Breeding	% of Attempts Successful	# Fledged/ Successful Attempt	# Fledged Per Pair	Total # Fledged
1976	14	83% (6)	83% (6)	3.56 (9)	2.45	34
1977	18	100% (12)	20% (10)	1.50 (2)	0.30	5
1978	18	83% (12)	43% (7)	3.20 (5)	1.14	21
1979	17	60% (15)	62% (8)	2.83 (6)	1.05	18
1980	17	71% (17)	92% (12)	2.70 (10)	1.76	30
1981	14	100% (6)	62% (8)	2.80 (5)	1.74	24
1982	13	83% (6)	83% (6)	3.00 (7)	2.07	27
1983	19	--	67% (3)	3.57 (7)	--	--
1984	20	--	62% (13)	3.29 (7)	--	--
1985	31	95% (20)	56% (25)	2.67 (12)	1.42	44
1986	28	50% (2)	60% (15)	2.43 (7)	0.73	20
1987	27	100% (4*)	80% (15)	3.15 (13)	2.52	68
1988	26	--	94% (16)	3.00 (14)	--	--

* In 1987, all 4 preselected pairs were on the PP&L line.

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TITLE: Nesting Density of Prairie Falcons and Red-tailed Hawks in the Snake River Birds of Prey Area.

INVESTIGATORS: John H. Doremus, Wildlife Biologist, Bruneau Resource Area
Randy M Trujillo, Wildlife Biologist, Bruneau Resource Area

OBJECTIVE: To monitor occupancy of prairie falcon (Falco mexicanus) and red-tailed hawk (Buteo jamaicensis) nesting territories in 8 randomly selected 10-km river units in the Snake River Birds of Prey Area (SRBOPA).

ANNUAL SUMMARY

Surveys of 8 randomly selected stretches of the Snake River Canyon suggested that prairie falcon and red-tailed hawk nesting densities were slightly higher in 1988 than in 1976-78. Some units showed increases, some showed decreases, and still others were unchanged.

METHODS

Eight 10-km river units in the SRBOPA (numbers 3, 6, 7, 8, 15, 24, 26, and 37) were surveyed in 1988. These units had been selected in 1986 using stratified random sampling; strata were based on falcon density in earlier years (Kochert et al. 1986). The units were searched on foot and by boat once each month from March through June for occupied prairie falcon and red-tailed hawk territories. Several territories on private property (Castle Rock, Mary's, Flat Iron Butte, and Walters Butte) were not surveyed in 1988 because they were not observable from public lands.

Results were contrasted with findings from 1976-1978, the years when all of these 10-km units were thoroughly surveyed. It was uncertain whether 1986 surveys were intensive enough to confirm vacancy of territories on the south side of the river in Unit 6 between the mouth of Sinker Creek and Balls Line West (Kochert et al. 1986). Therefore, this stretch was excluded from the comparison of 1986 and 1988 densities.

RESULTS

Prairie Falcons

Seventy-nine occupied prairie falcon territories were located in the 8 survey stretches in 1988 (Table 1). This total is slightly higher than the average number of pairs found in those same stretches between 1976 and 1978. The number of pairs located in 1988 was higher than in either 1978 or 1986. The 22% increase from 1986 may have resulted in part from incomplete surveys of the south side of Unit 6 in 1986. When this stretch was excluded, the increase was only 16% (71 pairs in 1988 versus 61 in 1986).

The increase in number of pairs found in 1988 did not occur uniformly throughout the area. The number of prairie falcon pairs in units 8 and 24

Table 1. Number of occupied prairie falcon territories in randomly selected 10 km units in the BOPA, 1976-78.

10 km Unit	1976	1977	1978	1976-78 (x)	1986	1988
3	0	0	1	(0.3)	0	1
6	32	32	30	(31.3)	23*	28
7	12	11	14	(12.3)	11	9
8	14	13	9	(12.0)	11	17
15	13	13	12	(12.7)	14	13
24	3	4	2	(3.0)	2	5
26	4	5	3	(4.0)	1	4
37	3	3	2	(2.7)	3	2
Total	81	81	73	78.3	65	79

* Surveys of the south side of the river between the mouth of Sinker Creek and Balls Line West may have been incomplete in 1986.

were higher than in any previous year that surveys were conducted. However, numbers in Unit 7 were lower than in past surveys. Numbers in the other units were within the range observed in past years and were close to the 1976-1978 average.

To supplement comparisons, we also examined data from 3 units (7, 8 and 15) that had been surveyed each year from 1976 to 1984 (Table 2). The 1988 count in those 3 units (39) was higher than the 11-year average (36.6). The 1988 count for Unit 15 was within the range of densities observed between 1976 and 1984; the count for Unit 8 was higher, and the count for Unit 7 was lower than in all previous years.

Red-tailed Hawks

The number of occupied red-tailed hawk nesting territories in the 8 survey stretches (27) was unchanged from the 1986 level (Table 3). Both the 1986 and 1988 levels were higher than densities observed from 1976 to 1978. Part of the increase may be due to hawks nesting on the Pacific Power 500 kV line in Unit 03. One red-tailed hawk pair nested on one of the line's towers in 1986, and 2 nested on towers in 1988. Counts in all other units were within the ranges of counts conducted in past years.

A comparison of 11 years of counts from Units 7, 8, and 15 showed that red-tailed hawk density was slightly below average in 1988 (Table 4). Counts in Unit 8 were above average, counts in Unit 7 were near average, and counts in Unit 15 were below average.

ACKNOWLEDGMENTS

T. Holthuijzen conducted surveys of prairie falcons in the Tick Basin area. J. Skinner also assisted with falcon surveys. We thank A. Okamoto for automating the data and K. Steenhof for analyzing our data and writing our report.

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Table 2. Number of occupied prairie falcon territories in 10-km survey units 7, 8, and 15 in the SRBOPA.

Year	7	8	15	Total
1976	12	14	13	39
1977	11	13	13	37
1978	14	9	12	35
1979	15	10	12	37
1980	13	11	10	34
1981	15	14	12	41
1982	11	12	10	33
1983	11	15	9	35
1984	11	11	15	37
1986	11	11	14	36
1988	9	17	13	39
Mean	12.1	11.5	12.1	36.6

Table 3. Number of occupied red-tailed hawk territories found in randomly selected 10-km river units in the SRBOPA.

10 km Unit	No. Occupied Territories				
	1976	1977	1978	1986	1988
3	1	1	1	3	4
6	7	8	6	6	7
7	6	5	4	4	4
8	4	4	4	5	5
15	3	4	4	3	2
24	2	1	1	3	3
26	1	1	1	3	2
37	1	0	1	0	0
Total	25	24	22	27	27

Table 4. Number of occupied red-tailed hawk territories in 10-km survey Units 7, 8, and 15 in the SRBOPA.

Year	7	8	15	Total
1976	6	4	3	13
1977	5	4	4	13
1978	4	4	4	12
1979	5	4	5	14
1980	5	3	4	12
1981	4	4	4	12
1982	3	3	4	10
1983	4	4	6	14
1984	5	4	4	13
1986	4	5	3	12
1988	4	5	2	11
Mean	4.5	4.0	3.9	12.4

TITLE: Raptor and Raven Nesting on the PP&L Malin to Midpoint 500 kV Transmission Line.

INVESTIGATORS: Karen Steenhof, Assoc. Leader, BLM Birds of Prey Research
Michael N. Kochert, Leader, BLM Birds of Prey Research
Jerry Roppe, Wildlife Biologist, Pacific Power & Light Co.
Mike Mulrooney, Line Patrolman, Pacific Power & Light Co.

COOPERATOR: Pacific Power and Light Company

OBJECTIVES:

1. To identify all occupied raptor and raven nests on the first 371 miles of the PP&L Malin to Midpoint 500 kV transmission line.

2. To ascertain nesting success and productivity of raptors and ravens nesting on the first 133 miles of the line.

3. To ascertain nesting success and productivity of golden eagles and ferruginous hawks nesting on natural substrate near the intensively studied portion of the line for comparative purposes.

4. To identify preferred nesting locations on the towers and to document how these locations relate to nesting success and possible contamination.

5. To assess physiographic features that may influence use of towers by nesting raptors and ravens.

INTRODUCTION

The construction of a 500 kV transmission line across southern Idaho and Oregon in 1980-81 provided government and industry biologists with an opportunity to investigate the biology of raptors and ravens nesting on transmission lines. The Pacific Power & Light Company (PP&L), in cooperation with the Bureau of Land Management (BLM), constructed 37 artificial nesting platforms (Nelson and Nelson 1976) along its 500 kV transmission line between Midpoint (Jerome), Idaho and Malin, Oregon (Fig. 1). Pacific Power & Light representatives, interested individuals, and BLM Birds of Prey Research biologists have surveyed the line since 1981. This report presents findings of the 1988 survey.

METHODS

Surveys were conducted in 3 study areas in 1988. The "intensive survey area" consisted of Miles 0-133 of the transmission line, and the "extensive survey area" consisted of Miles 134-371 (Fig. 1). To compare nesting success and productivity, golden eagles (*Aquila chrysaetos*) and ferruginous hawks (*Buteo regalis*) were surveyed in a third "canyon study area" extending along the Snake River and its major tributaries from Hagerman, Idaho to Mile 135.

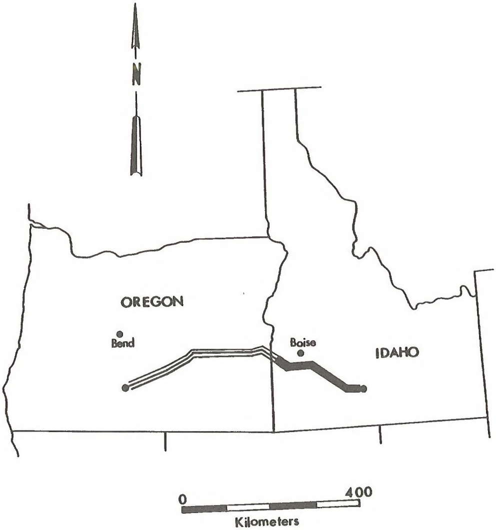


Fig. 1. Location of the Pacific Power and Light 500 kV transmission line. Intensive survey stretch is shaded.

The entire line was surveyed from a Hughes 500-D helicopter on 7 and 8 April to locate incubating pairs. One eagle nest on a cliff was also checked during the April survey. Follow-up surveys of the intensive study area were conducted from a Hiller/Soloy helicopter on 4 May and 19 May and a Bell 206 Jet Ranger on 7 and 16 June. The extensive area was re-surveyed on 18 May from a Messerschmidt Bocow BO 105. Thirty-five traditional golden eagle nesting territories in the Snake River Canyon were checked from a Hiller-Soloy on 16 March, and all were re-checked either from the ground or during helicopter flights in May or June. Occupied ferruginous hawk nesting territories within the BOPA were checked for productivity during ground surveys or later helicopter flights. During all surveys helicopters were flown at speeds of 70-95 km/hr; we usually hovered approximately 10 m from nests for 5-25 sec to view nest contents. Some nests were photographed from the helicopter, and some were subsequently observed from the ground.

Pairs were considered "breeding" if they laid at least 1 egg; this was confirmed by observing eggs, young, or an incubating adult. Because aerial surveys covered only the power line structures, some nonbreeding pairs could have been missed. We considered a breeding attempt successful if 1 or more young reached 80% of the average age when most young normally leave the nest. Nestlings were aged by comparison with photographs of known-age chicks (Moritsch 1983, 1985; BLM, unpubl. data).

RESULTS

Nest Density and Distribution

In 1988, 128 pairs of raptors and ravens occupied nests on 129 towers on the line. This total does not include 5 new nests in the extensive area. Because birds were never seen at these nests, occupancy could not be confirmed. Breeding attempts were confirmed for 122 of the 128 nesting pairs on the line (95%). Two golden eagle pairs (Miles 18 and 119) and 1 ferruginous hawk pair (Mile 86) were nonbreeders, and breeding could not be confirmed at 1 red-tailed hawk and 2 raven nests. There were 2 raven re-nesting attempts in 1988. One raven pair (Mile 106) re-used the same tower, and another (Mile 60) switched to a different tower. As in 1987, the golden eagle pair at Little Canyon Creek (49/3) nested on one of the traditional cliff nests, approximately 400 m from the line, in 1988.

Ravens were still the most numerous species nesting on the line. Eighty raven, 27 red-tailed hawk, 12 ferruginous hawk, 1 great horned owl, and 8 golden eagle pairs occupied nesting territories associated with nests on the line in 1988 (Table 1). The 128 occupied nesting territories represent a 2% decrease since 1987, the first decrease observed since surveys began in 1981. Red-tailed hawk pairs showed the sharpest decrease, declining from 33 in 1987 to 27 in 1988. The number of raven pairs decreased by 1, and the number of great horned owls was unchanged. A great horned owl pair nested in the same tower that was used by owls in 1987. Golden eagle pairs increased by 1, with a new territory established at Mile 125, and ferruginous hawk pairs increased by 3.

Table 1. Number of occupied raptor and raven nesting territories found on the PP&L Malin to Midpoint 500 kV transmission line, 1981-88.

Species	1981	1982	1983	1984	1985	1986	1987	1988
Golden Eagle	1	2	5	4	4	4	7	8
Ferruginous Hawk	1	3	9	7	6	8	9	12
Red-tailed Hawk	0	2	2	13	20	28	33	27
Common Raven	1	9	39	55	58	73	81	80
Great Horned Owl	0	0	0	0	0	0	1	1
TOTAL	3	16	55	79	88	113	131	128

The decrease in number of pairs from 1987 to 1988 occurred mainly in the extensive area (Table 2). The number of pairs in the intensive area increased by 2 while the number in the extensive area decreased by 5. Red-tailed hawks within the extensive area declined from 28 in 1987 to 22 in 1988, while numbers in the intensive area remained unchanged. The extensive area had 1 more raven pair than in 1987, and the intensive area had 2 fewer pairs. As in past years, ferruginous hawks and great horned owls nested only in the intensive area. Nesting densities of all species combined were higher in the intensive study area (0.34 per km; 0.55 per mi) than in the extensive area (0.15 per km; 0.25 per mi). For the entire line, densities averaged 0.21 nests per km or 8 nests for every 100 towers.

Significantly more breeding pairs occurred between Miles 59 and 127, within or just north of the Birds of Prey Area (BOPA), than in the remaining half of the intensive study area ($X^2 = 6.92$, $\underline{P} < 0.05$). As in past years, nesting densities were particularly high along one stretch of line within the BOPA (Miles 113-119). In 1988, this stretch contained more than 1 nesting pair per mile (0.7 per km), more than 3 times the average density for the line.

Nest Site Selection

Raptors and ravens nested in all tower types on the line. The frequency with which the tower types were used, however, differed significantly from the frequency with which tower types were available ($X^2 = 4.15$; $\underline{P} < 0.05$). Although A towers (Fig. 2) were the most commonly used towers, they were by far the most common tower type available. Only 7% of the A towers were used in 1988, and 15 of the 88 breeding pairs that nested on A towers nested on platforms and not on the tower latticework. In contrast, raptors and ravens nested on 35% of the available E towers, 25% of the T towers, and 12% F towers and 9% of the C towers. Only the B towers had a lower rate of use (3%) than the A towers; 1 of the 5 pairs nesting on B towers used an artificial platform. The sturdier and more extensive latticework on the less common T and E towers (Fig. 2) may provide more suitable nesting substrate and therefore account for the raptors' and ravens' apparent preferences for them.

Red-tailed hawks used more positions on the tower for nesting than the other 3 diurnal species (Fig. 3). The single pair of great horned owls used an old raven nest on the waist position. Ravens appeared to be the least versatile in nest site selection, nesting only in the x-position in 1988. The x-position of the tower (Fig. 3) was the most frequently used position on the towers, used by 77 breeding raven pairs, 12 of 26 red-tailed hawk pairs, 2 of 6 golden eagle pairs, and 5 of 11 ferruginous hawk pairs.

More than 50% of the golden eagle and ferruginous hawk pairs nested on the specially designed artificial platforms that were installed at the time of line construction. A preference by hawks and eagles for the platforms is apparent because only 2% of the towers on the line contain platforms. Sixteen of 37 available platforms were used by breeding raptors in 1988 (4 by golden eagles, 5 by ferruginous hawks, and 7 by red-tailed hawks). More platforms were used in 1988 than in any previous year. The platform in Tower 352/2 was used for the first time in 1988. Only 3 platforms that had been

Table 2. Number of occupied raptor and raven nesting territories found in the intensive and extensive study areas, 1984-88.

	Intensive					Extensive				
	1984	1985	1986	1987	1988	1984	1985	1986	1987	1988
Golden Eagle	4	4	4	4*	5*	0	0	0	3	3
Ferruginous Hawk	7	6	8	9	12	0	0	0	0	0
Red-tailed Hawk	4	2	4	5	5	9	18	24	28	22
Common Raven	37	38	47	53	51	18	20	26	28	29
Great Horned Owl	0	0	0	1	1	0	0	0	0	0
	52	50	63	72	74	27	38	50	59	54

* Does not include Little Canyon Creek (49/3) because the pair nested on a cliff in 1987 and 1988.

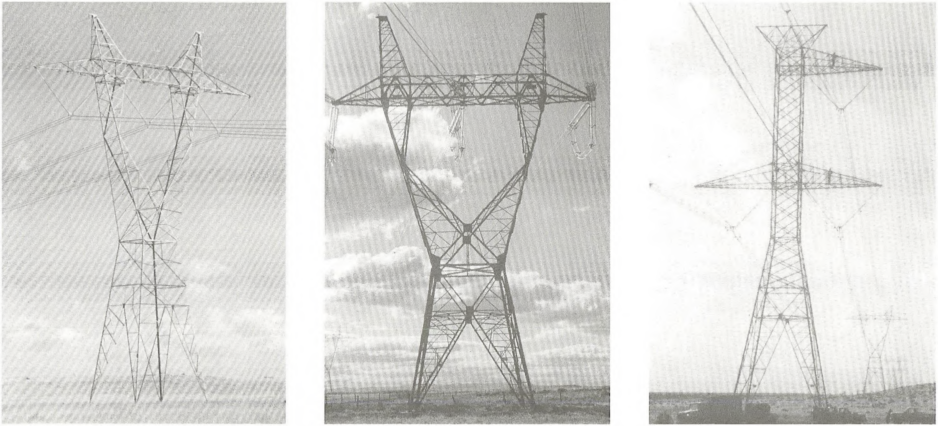


Fig. 2. Tower types used by raptors and ravens for nesting. The "E" (center) and "T" (right) towers were preferred over the more common "A" towers (left) apparently because of their sturdier and more extensive latticework.

Golden Eagle (N = 6)

X — — 33

P — — 67

Ferruginous Hawks (N = 11)

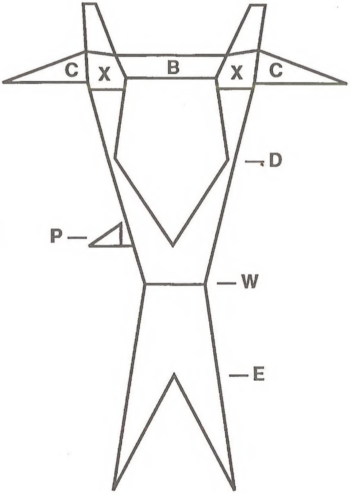
C — — 9

X — — 45

P — — 45

Great Horned Owl (N = 1)

W — — 100



Red-tailed Hawk (N = 26)

C — — 4

X — — 46

P — — 27

W — — 15

D — — 8

Common Raven (N = 77)

X — — 100

Fig. 3 Percent of raptor and raven breeding attempts in relation to tower position for the PP&L Malin to Midpoint 500kV transmission line, 1988. Sample sizes are shown in parentheses. Summaries do not include "T" towers.

used in previous years were not used in 1988. The eagle pair that has used the platform at 18/1 was present but did not breed in 1988; the Little Canyon Creek eagle pair nested on the cliff instead of on the 49/3 platform; and there was no sign of activity near the platform on 311/5 that was used by red-tailed hawks in 1985. Heights of the 16 platforms used for nesting in 1988 did not differ significantly ($t = 0.25$; $\underline{P} > 0.10$) from the 21 that were not used. Location seemed to be the best predictor of use; 10 of 12 platforms in the intensive area were used compared with only 6 of 25 in the extensive area.

The 77 raven pairs that nested in the x-position showed no significant preference for side of tower. Thirty-eight nested on the south end of the tower, and 39 nested on the north side. However, all 5 ferruginous hawks that nested in the x-position used the south side of the tower. Red-tailed hawks showed only a slight preference for x nests on the south side of the tower (7 of 12 attempts in the x-position).

Nest Site Fidelity

In 1988, 112 of 128 raptor and raven pairs (88%) nested within 2 towers of where a nesting attempt had occurred in earlier years. Ninety of these pairs (70%) nested on the same tower where an earlier attempt had occurred, and 83 of these (65%) nested in the same position on the tower.

All golden eagles that occupied traditional territories on the line in 1988 were associated with the same tower and nest that was used in 1987. Sixteen red-tailed hawk nests were in the same position as in earlier years, 3 were in the same tower but a different position, and 3 were in the same territory but a different tower. Five red-tailed hawk nests were in new territories, and 24 red-tailed hawk territories used in previous years were vacant. Ferruginous hawks built nests in 1 new territory; 3 pairs nested on a different tower in the same territory; 7 traditional territories were unoccupied, and 8 pairs nested in positions that were used in past years.

Seventy-one of 80 raven pairs nested within 2 towers of where a raven nesting attempt occurred in a previous year. More than half (55) of the ravens nesting on the line in 1988 nested in a tower that was used by ravens in earlier years. Fifty-one of these pairs used a position on the tower that was used in earlier years, and 39 of these used the same position used in 1988. Only 9 raven nesting attempts were in territories that had never been used previously. Thirty-three traditional raven territories were not used in 1988. Of these, 20 (61%) were in the extensive area. In 1988, raven pairs nested on adjacent towers for the 2nd time during the study (Towers 203/4 and 203/5).

Nesting Success and Productivity

Reproductive rates of raptors in the intensive study area were generally lower in 1988 than in 1987. Only 3 of 5 eagle pairs (60%) laid eggs, and 1 ferruginous hawk pair (Mile 86) did not breed (Table 3). Both percent of nesting attempts successful and number of young fledged per successful attempt declined for all diurnal raptors. The nesting great horned owl pair

Table 3. Nesting success and productivity of raptors and ravens on the PP&L Malin to Midpoint 500 kV transmission line (intensive survey stretch), 1988.

	No. of Pairs	% of Pairs Breeding	% of Breeding Attempts Successful	No. Fledged Per Succ. Attempt	No. Fledged Per Pair
Golden Eagle	5	60%	67%	1.0	0.4
Ferruginous Hawk	12	92%	82%	3.0	2.3
Red-tailed Hawk	5	100%	80%	1.5	1.2
Common Raven	51	100%*	88%**	3.6	3.2

* breeding was unconfirmed for 1 pair

** based on all 50 nesting attempts (including re-nests) where outcome was known. The Mayfield (1961) estimate of nesting success as 92%.

produced young, but it is not known whether the young reached fledging age. For each of the species, number of young fledged per pair in the intensive area was lower in 1988 than in 1987, averaging 0.4 for golden eagles, 1.2 for red-tailed hawks, and 2.3 for ferruginous hawks (Table 3). Number of young fledged per raven pair was unchanged from 1987 (3.2). Although the percent of nesting attempts that were successful increased, number of young fledged per successful attempt dropped from 4.0 to 3.6.

Wind was the only confirmed cause of nest failure in 1988; a ferruginous hawk nest with young in the x-south position of 72/2 was blown out between 19 May and 7 June. In addition, ferruginous hawk young from 104/4 were lost when National Guard personnel and a local rehabilitator collected 3 apparently healthy fledglings on 25 June. The young were never returned to the wild. The same rehabilitator collected a ferruginous hawk fledgling from 109/2. However, this bird was released, rejoined its natal brood, and was radio-tracked by BSU graduate student Alison Beck through the end of July.

An analysis of 1983-1988 nesting data from the transmission line and surrounding areas revealed that ferruginous hawks nesting on the transmission line had significantly higher nesting success rates ($G = 7.94$; $P = 0.004$) than pairs nesting on cliffs and other natural substrates. Golden eagles nesting on the 500 kV line also had higher success rates than eagles nesting on cliffs, but the difference was not statistically significant ($G = 1.42$; $\underline{P} = 0.23$). Red-tailed hawk nesting success did not differ significantly among nesting substrates in the study area ($G = 0.45$; $\underline{P} = 0.50$); cliff nesters fared slightly better than those that nested on transmission towers. Golden eagles that nested in platforms had significantly higher success rates than eagles nesting in other parts of the tower ($G = 4.90$; $\underline{P} = 0.003$). Success rates for ferruginous hawks were also higher in platforms; success rates for red-tailed hawks were slightly lower in platforms. Neither of the differences were statistically significant (G's = 3.20,1.64; P's >0.05).

DISCUSSION

The number of raptors and ravens nesting on the line decreased for the first time since 1981. Even though at least 5 pairs in the extensive area may have been missed because of survey timing, the data suggest that the number of nesting pairs has started to level off. Nesting densities on the transmission line continue to be higher in Idaho than in Oregon. In Idaho, the line is closer to established nesting populations in the Snake River Canyon that may be the source of birds using the line (Kochert et al. 1984).

Over the past 6 years, nesting success of ferruginous hawk and golden eagle pairs has been higher on the transmission lines than on surrounding natural substrate. Possible reasons for the difference are that the power line offers a better thermal environment, protection from predators, and protection from fire (Steenhof et al. 1987). In addition, the prey in the vicinity of power line nests may be more abundant, vulnerable and/or disease-free (Steenhof et al. 1987). We have found no evidence that birds nesting on the line are adversely affected by the line's electromagnetic field (EMF). Raptors may, in fact, be ideal study subjects for an investigation of electromagnetic field effects because raptors live in very close proximity to the transmission line wires and wires are probably the only source of EMF

that the birds encounter in their lifetimes. Future studies of EMF effects on raptors should assess survival rates of both nesting adults and their young in addition to reproductive rates.

PLANS FOR NEXT YEAR

Surveys of nesting raptors and ravens on the line will continue using the same procedures as in 1988. In addition, we will continue to gather comparative data on reproduction of golden eagles and ferruginous hawks nesting in the canyon. Habitat surrounding nesting and random towers in the extensive area will be characterized as maps, photos, and funding become available.

ACKNOWLEDGMENTS

We thank our pilots: S. Sandmeyer, R. Franz, T. Miller, R. Mason, T. Handell (Idaho Helicopters) and J. Judge, (Pacificorp). K. Engel gathered data that helped to interpret nest fates. M. Garrett also assisted with data collection and compilation. L. Young and S. Wilder provided logistical support that made the study possible.

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TITLE: Implications of Communal Roosting by Common Ravens to Operation and Maintenance of the Malin to Midpoint 500 kV Transmission Line.

INVESTIGATORS: L. S. Young, Wildlife Biologist
K. A. Engel, Wildlife Biologist

COOPERATOR: Pacific Power

OBJECTIVES:

1. To monitor occupancy of raven roosts and trends in numbers of roosting ravens between miles 83-160 of the Malin to Midpoint 500 kV transmission line.

2. To evaluate the effectiveness of shields in preventing insulator contamination at the Marsing Southwest Roost.

INTRODUCTION

Research to determine the implications of communal roosting by common ravens (Corvus corax) to operation and maintenance of the Malin to Midpoint 500 kV transmission line was completed in 1987. Fieldwork during 1988 involved monitoring occupancy of raven roosts and trends in numbers of roosting ravens between line miles 83-160 (the intensive study area in which research was conducted from 1983-87) and evaluating the effectiveness of shields in preventing insulator contamination at the Marsing Southwest Roost (line miles 153-156). This report presents the results of the 1988 monitoring effort.

METHODS

Monitoring Occupancy of Roosts and Numbers of Roosting Ravens

Surveys

Line miles 83-160 were surveyed once a month to identify towers used by roosting ravens. Surveys were conducted on 2 consecutive days, usually the second Monday and Tuesday of the month. Line miles 83-105 were not surveyed during April and May. Instead, these towers were checked for contamination during helicopter surveys that were part of the raptor and raven nesting study. Surveys were not conducted during September or December due to time and personnel constraints. Spot inspections of suspected roost towers outside line miles 83-160 were made at the request of the line patrolman.

Insulators of each tower were inspected by an observer with binoculars driving along the maintenance road adjacent to the line. Surveys began no later than 1 hour after sunrise and were completed no later than 1 hour before sunset. Newly occupied roost towers were identified by contaminated insulators. Increased contamination and fresh pellets and feathers indicated reoccupancy of previously used towers.

Coordinated Roost Observations

All occupied roosts between line miles 83-160 were simultaneously observed once a month, usually on the second Thursday of the month. Coordinated roost observations were not made during September or December due to personnel constraints.

At each roost, observations were made from a vehicle parked at a good vantage point at least 400 m from the nearest roost tower. Observations began 10 min before sunset and continued until it was too dark to accurately count ravens (usually 30 min after sunset). Every 10 min, an observer with a spotting scope counted the number of ravens on each tower section (Young and Engel 1988: Fig. 3-1). The highest total number of ravens counted during a 10-min interval was considered the count for the roost.

Monitoring the Effectiveness of Shields

Shields were installed on 21 towers (153/3 - 158/2, except 156/5) at the Marsing Southwest Roost from 10-14 May 1988. Shields protected the inner 4 insulator strings of each tower. The outer 2 strings were not protected; pegging was not attached to the outer C sections, as was done at the Wilson Creek Roost (Young and Engel 1988).

Contamination Estimates

Contamination levels were monitored at all but 4 towers fitted with shields. Estimates could not be made at towers 153/3, 154/3, 156/3, and 156/4, which have opaque, porcelain insulators. The first series of estimates was made on the day that installation was completed (14 May). The second series of estimates was made 2 months later. Thereafter, contamination levels were estimated monthly, usually during the third week of the month. Inclement weather prevented estimates from being made during November.

Estimates were made by an observer with binoculars situated at the base of the tower. The observer separately scored each insulator bell according to visual criteria (Young and Engel 1988: Fig. 3-2). To ensure consistency, estimates were not made on overcast days, and the observer always positioned himself directly beneath the line, 15 m from the base of the tower, with the sun at his back.

We evaluated the effectiveness of shields in preventing insulator contamination by comparing May and October insulator scores. Between October and December estimates, 85.6 mm of rain fell, and rain fell on 32 of 54 days (Natl. Oceanic and Atmospheric Admin., unpubl. data). This provided considerable natural washing of insulators, which would have confounded an attempt to assess the effectiveness of shields between May and December. In contrast, between May and October estimates, only 48.0 mm of rain fell, and rain fell on only 19 of 160 days. We compared May and October insulator scores for each tower used by ravens using 2-sample median tests. Likewise, we examined the effects of 2 months of relatively heavy precipitation by comparing October and December scores. We evaluated effects separately for center and outer string insulators. Center insulators were protected by

shields; outer insulators were not. Tests were evaluated at the 0.05 level of significance.

Roost Observations

To monitor responses of roosting ravens to shields, the Marsing Southwest Roost was observed once a week, usually on a Thursday or Friday evening. Observations were made from April through mid-December. To evaluate the immediate response of ravens to shields, observations were also made on the evening installation was completed and the next evening (14-15 May). Weekly and supplemental observations were made according to the same procedures described for coordinated observations.

RESULTS

Occupancy of Roosts and Numbers of Roosting Ravens

Four roosts within line miles 83-160 were occupied during 1988 (Table 1). Four other roosts occupied in previous years were not occupied during 1988. No new roosts were located within line miles 83-160. Numbers of ravens increased through the spring and early summer, reached a peak during late summer, then declined in autumn.

One new roost was located outside line miles 83-160. M. Mulrooney (Pacific Power, pers. commun.) observed contaminated insulators at tower 176/3 during a late September helicopter patrol. A ground inspection on 18 October revealed that tower 176/3 had indeed been used by ravens. Insulators on the 4 central strings were contaminated; most had scores of 1, but a few had scores of 2. Most insulators on the 2 outer strings were not contaminated, but a few had scores of 1. Three raven feathers and about 30 regurgitated pellets were found beneath the tower during a 10-min search. Pellets did not appear to be fresh. The roost was probably used during the summer and/or early autumn and evacuated before the 18 October ground inspection. The amount of contamination and number of pellets found beneath the tower suggested that relatively few ravens (< 50 or perhaps just a family group) had used the tower. There was no evidence that ravens had roosted on adjacent towers (towers 176/1-2, 176/4, 177/1). The nearest occupied raven nest on the transmission line during spring 1988 was at tower 171/5; however, there are several cliffs and rocky outcrops close to tower 176/3 that may be used by nesting ravens.

Effectiveness of Shields and Pegging

Immediate Response of Ravens

On 14 May, shields were installed on tower 155/1, the tower that was currently being used by ravens. That evening, ravens flew to tower 155/1 and roosted without apparent hesitation.

Table 1. Numbers of ravens counted at communal roosts within line miles 83-160 during coordinated roost observations, 1988.

Roost (line miles)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ditto Creek Road (85-86)	a	a	a	a	a	a	a	a	b	a	a	b
Pleasant Valley Road (101-105)	a	a	a	a	a	a	a	a	b	a	a	b
Initial Point (106-113)	0	401	458	280	392	341	437	787	b	843	337	b
Swan Falls Road (114-117)	a	a	a	a	a	a	a	a	b	a	a	b
Wilson Creek (131-132)	a	a	a	29	89	157	348	391	b	0	a	b
Marsing Dump (148-150)	a	a	a	a	a	a	a	195	b	310	0	b
Marsing Southwest (153-156)	0	0	82	173	82	86	130	248	b	154	297	b
Total	0	401	540	482	563	584	915	1621	b	1307	634	b

[a] not occupied, not observed.

[b] coordinated roost observations not made this month.

Use of Towers

Ravens roosted on tower 155/1 on 14 and 15 May, the first 2 evenings after the installation was completed. Ravens roosted on towers between 155/1 and 156/3 from May through October. During November and December, ravens roosted on towers both east and west of this segment, including 6 towers rarely or never before used. On 15 December, the last day observations were made, ravens roosted on tower 153/2, an untreated tower at the east end of the Marsing Southwest Roost.

Numbers of Ravens

Numbers of ravens using the Marsing Southwest Roost declined steadily during late April and early May (Fig. 1). Numbers remained low during the installation period and fluctuated throughout the summer before rising sharply in late August to reach a 1988 peak of 362 ravens on 22 September. Numbers fluctuated widely during the autumn and early winter.

Distribution of Ravens Among Tower Sections

Significantly fewer ravens roosted above insulators during the first 3 weeks following installation than before installation or after the first 3 weeks following installation (1-way ANOVA, $\underline{F} = 12.819$, df = 2, $\underline{P} < 0.001$). Fewer ravens roosted on the C and AW sections during the first 3 weeks, while more roosted on the D section (Table 2). Ravens returned to the AW sections after the first 3 weeks but continued to use the C sections less than they had before the installation. Decreased use of the C sections was largely compensated by increased use of the A and D sections.

Contamination

Ravens were observed roosting on 7 towers at the Marsing Southwest Roost between May and October. Median scores of center string insulators did not increase significantly at any of the 6 towers at which estimates were made, despite large numbers of ravens roosting above insulators (Table 3). In fact, significant decreases in median scores were observed at 4 of the 6 towers. Median scores of outer string insulators increased significantly at 3 towers at which large numbers of ravens roosted on the C sections (Table 3). Median scores of outer insulators did not change significantly at a fourth tower at which large numbers of ravens used the C sections, and decreased significantly at 2 towers at which few ravens roosted on the C sections.

Five of the 7 towers used by ravens between May and October were not used by ravens between October and December. Between October and December median scores of center insulators decreased significantly at 1 tower and did not change significantly at the other 4 (Table 4). Median scores of outer insulators decreased significantly at 3 towers and did not change significantly at the other 2.

Six towers not used between May and October were used between May and December. One was a tower that has commonly been used by ravens in previous years, and 5 were towers that have rarely or never been used. Median scores of both center and outer insulators did not change significantly at the

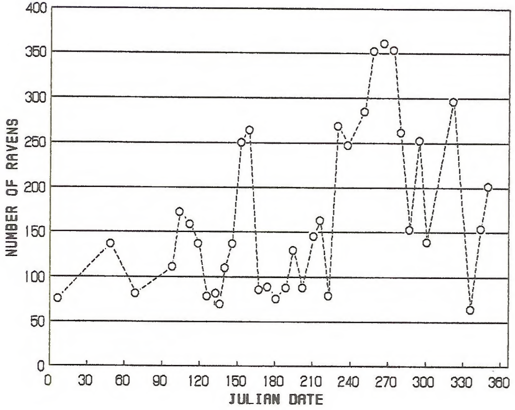

Fig. 1. Numbers of ravens counted at the Marsing Southwest Roost, 1988.

Table 2. Distribution of ravens among tower sections at the Marsing Southwest Roost before installation of shields (1984 - 13 May 1988), during the first 3 weeks after installation (14 May - 7 June 1988), and after the first 3 weeks (8 June - 15 December 1988). Only evenings on which there was no precipitation and winds did not exceed 8 km/hour are included.

			Tower Section (%)							
Period	No. Tower-Evenings	Above Insulators (%)	C	X	A	AW	B	D	W	E
Before Installation	158	98.7	24.0	3.8	27.4	7.0	36.4	0.7	0.7	0.0
First 3 Weeks After Installation	3	77.2	13.5	4.2	27.1	0.0	32.5	22.8	0.0	0.0
After First 3 Weeks	55	96.8	13.9	2.8	34.4	7.9	37.9	3.1	0.1	<0.1

Table 3. Use of towers and contamination trends at the Marsing Southwest Roost following installation of shields, 14 May - 21 October 1988.

	$\bar{X}$ No. Ravens/Night		Contamination trend (May - Oct)[a]	
Tower	Above Insulators	On C Sections (n)	Center Insulators	Outer Insulators
155/1	48.2 ± 33.3	4.9 ± 6.7 (9)	D (X^2 = 49.316, P < 0.001)	D (X^2 = 17.898, P < 0.001)
155/2	83.1 ± 48.2	18.3 ± 15.7 (14)	D (X^2 = 16.536, P < 0.001)	N (X^2 = 1.415, P = 0.234)
155/3	52.7 ± 21.1	5.1 ± 5.0 (9)	D (X^2 = 4.640, P = 0.031)	D (X^2 = 18.063, P < 0.001)
155/4	67.5 ± 40.0	14.2 ± 12.3 (8)	D (X^2 = 6.498, P = 0.011)	I (X^2 = 4.433, P = 0.035)
156/1	94.3 ± 74.3	21.9 ± 19.9 (7)	N (X^2 = 2.344, P = 0.126)	I (X^2 = 16.741, P < 0.001)
156/2	79.8 ± 48.8	20.2 ± 18.2 (6)	N[b]	I (X^2 = 16.741, P < 0.001)
156/3	47.0 ± 42.4	4.0 ± 5.7 (2)	[c]	[c]

[a] D = significant decrease, I = significant increase, N = no significant change.

[b] All insulator scores were equal, test statistic could not be calculated.

[c] Porcelain insulators, contamination could not be estimated.

Table 4. Use of towers and contamination trends at the Marsing Southwest Roost, 21 October - 15 December 1988.

	$\bar{X}$ No. Ravens/Night		Contamination trend (Oct - Dec)[a]	
Tower	Above Insulators	On C Sections (n)	Center Insulators	Outer Insulators
Towers Used During May - Oct, Not Used During Oct - Dec:				
155/1	0.0	0.0	N (X^2 = 3.368, P = 0.067)	D (X^2 = 10.214, P = 0.001)
155/2	0.0	0.0	N (X^2 = 1.255, P = 0.263)	N (X^2 = 2.367, P = 0.124)
155/3	0.0	0.0	N (X^2 = 0.354, P = 0.552)	N (X^2 = 0.000, P = 1.000)
155/4	0.0	0.0	N (X^2 = 3.183, P = 0.074)	D (X^2 = 84.946, P < 0.001)
156/1	0.0	0.0	D (X^2 = 11.458, P = 0.001)	D (X^2 = 67.348, P < 0.001)
Towers Not Used During May - Oct, Commonly Used From 1984-87:				
154/4	110.0 ± 63.6	16.0 ± 22.6 (2)	N (X^2 = 0.000, P = 1.000)	N[b]
Towers Not Used During May - Oct, Rarely or Never Before Used:				
154/1	0.0[c]	0.0[c]	I (X^2 = 19.580, P < 0.001)	I (X^2 = 26.240, P < 0.001)
154/2	0.0[c]	0.0[c]	I (X^2 = 5.321, P = 0.021)	I (X^2 = 24.533, P < 0.001)

Table 4. Continued.

	$\bar{X}$ No. Ravens/Night		Contamination trend (Oct - Dec)[a]	
Tower	Above Insulators	On C Sections ($\underline{n}$)	Center Insulators	Outer Insulators
Towers Not Used During May - Oct, Rarely or Never Before Used (Continued):				
156/4	297.0 ± 0.0	73.0 ± 0.0 (1)	[d]	[d]
157/2	0.0[c]	0.0[c]	I (X^2 = 15.844, $\underline{P}$ < 0.001)	N (X^2 = 0.000, $\underline{P}$ = 1.000)
157/3	0.0[c]	0.0[c]	I (X^2 = 40.048, $\underline{P}$ < 0.001)	I (X^2 = 74.436, $\underline{P}$ < 0.000)

[a] D = significant decrease, I = significant increase, N = no significant change.

[b] All insulator scores were equal; test statistic could not be calculated.

[c] Never observed used, use inferred from contaminated insulators, and pellets and feathers beneath tower.

[d] Porcelain insulators, contamination could not be estimated.

previously used tower (Table 4). Median scores of center insulators increased significantly at all 4 new towers at which estimates were made, and median scores of outer insulators increased significantly at 3 of these 4 towers.

DISCUSSION

Overall patterns of roost occupancy were similar to those observed in previous years. As in 1987, the Initial Point Roost was used almost year-round; only in January were no ravens observed there during coordinated observations. Overall numbers of ravens roosting on the line were also comparable to previous years, although peak counts at the 2 largest roosts on the line, Initial Point (843) and Marsing Southwest (362), were lower than in previous years. This is the first year that the peak count at the Initial Point Roost failed to exceed 1,000 ravens.

Raven response to the installation of shields was negligible. Ravens roosted on the same tower they had been using on the evening that installation was completed and did not exhibit the type of avoidance reaction observed on the evening the Wilson Creek Roost installation was completed in 1985. The only obvious change after the installation was completed was a decrease in the proportion of ravens roosting on the C sections.

Shields were largely effective in preventing contamination of center string insulators. However, when shields were installed gaps were inadvertently left between the 2 center shield segments. From the ground, these gaps appeared to be 15-30 cm (6-12 inches) wide. These gaps allowed fecal material to contaminate the 2-4 lowest insulators of each center string. Although it is unlikely that contamination of only 2-4 insulators on each of the center strings poses an operational risk (C. Wright, Pacific Power, pers. commun.), these gaps could be eliminated by slightly increasing the length of each segment or adjusting the positioning of segments during installation.

The October to December increases in scores of center string insulators of towers rarely or never before used are attributable to the almost perfectly clean state of the insulators before ravens began to use the towers. Although shields were effective in preventing most fecal material from reaching insulators, enough fecal material fell through cracks and gaps between shield segments to cause statistically significant increases in insulator scores, i.e., to cause many insulators to increase from a score of 0 (perfectly clean) to 1 (< 10% translucent). Even a single spatter of fecal material caused an insulator to increase from 0 to 1. While it was valuable to have the opportunity to discern this process, it is unlikely that the amount of material that thus reaches insulators would ever constitute an operational risk.

Shields did not prevent contamination of outer insulator strings. Significant increases in contamination of outer insulator strings were recorded at 3 of 6 towers used by ravens during the evaluation period. These towers were those at which 15-20 ravens roosted on the C sections each night. At 2 of these towers many insulators had scores of 3 in October. Scores would likely have increased to 4 in November, but ravens shifted away from these towers, and heavy rains washed away much of the contamination.

It is apparent from the 15 December observation of ravens roosting on tower 153/2 that too few towers were treated at and adjacent to the east end of the Marsing Southwest Roost. This risk was evaluated when the installation was planned in 1987; ravens were known to occasionally use towers in line mile 153. The decision was made to allocate limited resources to protect the center and west end of the roost, recognizing that more towers might need to be treated at the east end of the roost.

MANAGEMENT RECOMMENDATIONS

Results of monitoring conducted during 1988 give rise to 4 recommendations.

1. Pegging should be installed on the outer C sections of towers at the Marsing Southwest Roost and in future applications. Shields did not protect outer insulator strings; outer strings were significantly contaminated at towers where 15-20 ravens/night roosted on the C sections.

2. The 15-30 cm (6-12 inch) gap between the 2 center shield segments should be reduced in future applications. At the Marsing Southwest Roost, these gaps allowed fecal material to contaminate the 2-4 lowest insulators of each center string.

3. Additional towers at and adjacent to the east end of the Marsing Southwest Roost should be treated with shields and pegging. It was recognized that this might be necessary when the Marsing Southwest installation was planned in 1987. At least towers 153/1 and 153/2 should be treated.

4. Monitoring recommended in the final study report (Young and Engel 1988) should be continued. Discovery of a new roost at line mile 176 and use of an untreated tower at the east end of the Marsing Southwest Roost indicate the need for continued monitoring. The relatively small amount of funds needed to conduct the monitoring program (< $5,000/year) seems a prudent investment compared to the likely $100,000 + cost of a contamination-induced outage.

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Jerry Roppe, Mike Kochert, and Karen Steenhof guided the 1988 monitoring effort. Mike Mulrooney and Steve Wilder provided support and assistance in many forms. We thank Alison Beck, Allison Brody, Rob Gerber, Toni Holthuijzen, Dawn McAnnis, Angie Okamoto, Dana Quinney, Robin Spahr, Karen Steenhof, Mike Sutton, Kris Timmerman, and Jay Weaver for their assistance with coordinated roost observations.

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Young, L. S., and K. A. Engel. 1988. Implications of communal roosting by common ravens to operation and maintenance of Pacific Power and Light Company's Malin to Midpoint 500 kV transmission line. Pacific Power and Light Co., Portland, Ore. 154pp.

TITLE: Behavior and Productivity of Nesting Prairie Falcons in Relation to Construction Activities at Swan Falls Dam.

INVESTIGATOR: A.M.A. Holthuijzen, Idaho Power Company

COOPERATORS: Idaho Power Company
Pacific Gas and Electric Company

OBJECTIVES:

1. To evaluate the possible effects of construction and recreation activities on the behavior and productivity of nesting prairie falcons.

2. To establish a data base from which raptor management guidelines can be developed for industries and government agencies as well as for the BOPA.

RESULTS

Field work was completed in 1987. In 1988, data were analyzed, and the final report was written. The report was reviewed by Dr. T. Edwards, J. Enderson, G. Orians, and C. White and will be finalized in the spring of 1989. The final report is expected to be available to the general public in the summer of 1989. Five publications have been prepared based on the prairie falcon study and are under internal review; 2 others are in preparation.

ANNUAL SUMMARY

The final report summarizes the results of investigations sponsored jointly by Idaho Power Company, the Bureau of Land Management and Pacific Gas and Electric Company from 1984 to 1987. The study was initiated in 1984 to evaluate the potential effects of construction activities on nesting prairie falcons at the Swan Falls Dam hydroelectric power plant located in the Snake River Birds of Prey Area (BOPA). The study had 2 objectives: (1) to evaluate the possible effects of construction and recreation activities on the behavior and productivity of nesting prairie falcons, and (2) to formulate management guidelines for nesting prairie falcons.

Construction activities at Swan Falls Dam occurred from 1983 to 1986. In 1983-1984, an existing unpaved road leading down into the canyon was rebuilt. In May 1985, construction activities at the spillway started. In 1986, heavy construction continued throughout the nesting season. Possible latent effects of construction were evaluated in 1987.

Productivity has most often been used to evaluate the effects of human activities on nesting raptors; subtle behavioral repertoire was examined and correlated with variables measuring construction and recreational activities. The study involved detailed, continuous observations of the

behavior of nesting prairie falcons. Observations were made at nesting territories within 1000 m of Swan Falls Dam (construction study location, 1984-1987), areas heavily used by visitors (recreation study location, 1985-1987), and a control study location (1985-1987). A controlled blasting experiment was conducted outside the BOPA in 1985 (Reynolds Creek) to separate the effects of blasting from other construction activities. Each aerie in the blasting study location was exposed to 3 blasts a day (167 g ammonium nitrate, 138-146 dB) at 3-hour intervals. This blasting sequence was repeated every other day until young were 35 days old, totaling 87-92 blasts per aerie. In each of the 4 study locations, 4-6 prairie falcon nesting attempts were observed each year, totaling 54 nesting attempts (52 pairs) from 1984 to 1987. Observations of nesting pairs began during the last week of March and the first week of April (when the falcons had selected their aeries) and continued until the young were 30-35 days old. Observations started 30 min before sunrise and ended 30 min after sunset. A total of 632 days of observation (9,380 hours) were made (pre-incubation, 91 days; incubation, 267 days; brood-rearing, 255 days; and post-failure, 19 days). The time (minutes) spent on predetermined behaviors by male and female falcon pairs was recorded. Frequency and duration of these behaviors were calculated for each sex for an observation day. Observation days were categorized into 6-day intervals based on the approximate stage of the nesting season and labeled by midpoints.

Productivity of nesting pairs was determined by counting the number of young that were 30 days old in each occupied territory. Surveys in the BOPA started in the second week of March; surveys in the blasting study location began in the first week of April. To determine productivity all territories were revisited at 2-3 week intervals starting in mid-May. In 1986 and 1987, 151 nestlings were weighed, and 148 were banded. Body weight was used to determine physical condition of a falcon.

Two indexes to construction and recreation activities were measured at or near each of the observed nesting territories: (1) traffic flows (daily number of vehicles passing traffic counters), and (2) recreation activities recorded during daily visitor use surveys from late March through June. All nesting territories observed from 1984 to 1987 were ranked according to 7 human activity indexes. The ranking scores were summed per nesting territory and used in correlation analyses with falcon behaviors.

Two approaches were used to test the possible effects of human activities on prairie falcon behavior. Principal component factor analyses were used to investigate associations between human activities and the behaviors of male and female falcons nesting in the construction and recreation study locations. Stepwise discriminant analysis was used to test for differences in behavior among the study locations. Separate univariate analyses were conducted with behaviors that were considered critical to the nesting cycle and sensitive to human activities.

Behaviors of male and female falcons did not show strong and consistent relationships with human activity in the construction and recreation study locations. Some associations were found, but they appeared to be more related to behavioral changes over the nesting season than to human activities. The behavioral repertoire of male and female falcons showed few differences among the 4 study locations.

Percent incubation did not differ among study locations. The average duration per day that eggs were unattended differed among years and nesting pairs, but not among study locations. Percent of day brooding decreased similarly over time among years, among study locations for all years combined, and among study locations for each separately.

When human activities interfere with feeding over an extended period, chick mortality may increase because of excessive weight loss or intensified sibling rivalry. Prey delivery rates and the procurement time per prey item did not differ among study locations when all years or all nesting stages were combined. The relationship between prey delivery rates and human activity was not significant.

The measures of prey procurement (prey delivery rate, prey capture index, and out-of-canyon trips/pair/day) showed substantial differences among years. Trends were similar for all measures and were strongest for the brood-rearing stage; 1986 and 1987 were the extremes. In 1986 prey delivery rates and prey capture time were high, but the number of out-of-canyon trips/pair/day was low; 1987 showed opposite trends. Prey delivery rates decreased with progressively later hatch dates. Prey delivery rates and the proportion of Townsend's ground squirrels in a falcon pair's diet increased with the number of young fledged per pair. There was a strong decrease in productivity of progressively later nesting falcons.

The amount of time per day that a pair was absent from the nesting territory and unable to incubate eggs or brood young showed 3 distinct stages coinciding with the 3 stages of the nesting cycle. Prairie falcons were progressively less absent from the nesting territory during pre-incubation, almost continuously present during incubation, and increasingly absent during brood-rearing. Absence from the nesting territory differed among years and nesting stages, but not among study locations or nesting pairs. Percent absence during brood-rearing was similar between 1984 and 1987, but was higher in 1985 and highest in 1986.

Occupancy of nesting territories in each of the 3 BOPA study locations in 1984-1987 was similar to 1976-1978, when complete surveys were carried out. Differences in productivity were not found among study locations for 1984-1987. Productivity of prairie falcons was not correlated with human activity in each nesting territory. Significant correlations were not found between mean weight of nestlings and human activity. Nest failures occurred in all BOPA study locations. Three failures occurred in both the construction and control study locations, but 8 occurred in the recreation study location, 5 being in an area with high visitor use (Halverson Lake). The behavioral repertoire of falcon pairs whose nesting attempts failed was similar to that of successful nesting pairs in the control study location.

Falcons, when present, reacted to blasting in 137 of 254 instances (54%). Incubating and brooding falcons were flushed in 25 of 112 instances (22%), but returned to their nests within 3.4 ± 0.7 (SE) min. Eggs were never dislodged when incubating falcons were flushed. The behavioral repertoire of falcons exposed to experimental blasting was similar to that of control pairs. All pairs exposed to experimental blasting and 2 of 4 pairs exposed to construction blasting fledged young the year blasting took place. All nesting territories exposed to experimental blasting were occupied the

year following blasting. In the second year following experimental blasting, 3 of the 4 nesting territories were vacant. The vacancy rate did not significantly differ between nesting territories exposed to experimental blasting and those that were not.

Investigators did not affect the behaviors of falcons by approaching observation blinds placed 70-250 m from the aeries, or by different modes of access. No appreciable differences were found between observations collected from within or outside a blind. Observations collected from within or outside a blind were qualitatively and quantitatively similar in this study.

In general, this study demonstrated that construction and recreation activities had no detectable adverse effects on nesting prairie falcons. Some behaviors varied slightly, whereas others exhibited considerable variation. The relatively stable behaviors appear to be particularly useful in evaluating human activities because small deviations could cause a nest failure.

TITLE: Use of Nest Boxes by American Kestrels in Southwestern Idaho.

INVESTIGATORS: Karen Steenhof, Wildlife Research Biologist, B.L.M
Craig Groves, Nongame Program, Idaho Dept. of Fish and Game

COOPERATORS: Idaho Department of Fish and Game, Nongame Program
Idaho Department of Transportation
The Nature Conservancy

OBJECTIVES:

1. Determine kestrel occupancy rates and nesting success at boxes erected in southwestern Idaho.

2. Ascertain food habits of American kestrels nesting in boxes placed in a variety of habitats.

3. Mark nestling and adult kestrels to accumulate baseline data for future studies on dispersal and population dynamics.

INTRODUCTION

This study began in 1985 when nest boxes were erected on abandoned power poles in the Snake River Birds of Prey Area in an effort to learn more about the food habits and breeding biology of American kestrels (*Falco sparverius*) in southwestern Idaho (Steenhof et al. 1985). The limited use of those boxes prompted curiosity about factors that influence occupancy rates. In 1986, the Idaho Fish and Game Department's Nongame program joined the study, and the study area expanded to include agricultural and suburban habitat in the Kuna area as well as Interstate 84 between Simco Road and Caldwell.

METHODS

In 1988, 76 boxes were available to kestrels for nesting in southwestern Idaho. Six boxes had fallen or deteriorated since the nesting season of 1987. Thirty of the boxes were on trees within agricultural habitat in the vicinity of Kuna, Idaho (hereafter referred to as the Kuna Route), 30 were on signs along Interstate 84 between Simco Road and Caldwell (hereafter referred to as the I-84 Route), and 16 were on power poles along the north rim of the Snake River Canyon (herafter referred to as the BOPA route).

Each box on the Kuna and I-84 route was checked at least twice during the nesting season. The BOPA boxes were checked only once. All boxes were checked in mid-May, and most were re-checked in June. All boxes with viable nesting attempts were re-visited as necessary to band young and ascertain nesting success. Nests with young that were 75% feathered were considered successful. Investigators checked boxes from a ladder or while standing on a vehicle. When checking boxes, investigators inserted a hole stuffer into the nest box entrance to trap any adult birds in the box. Adults and young were weighed with a 300 g Pesola balance. Kestrel eggs that did not hatch after the normal period of incubation were collected, stored in a refrigerator, and

transferred to Lowell McEwen for chemical analysis. Nests of European starlings (Sturnus vulgaris) were removed in an effort to keep all boxes suitable for kestrel nesting.

RESULTS

Twenty-two of the 76 boxes were used for nesting by kestrels, 31 were used by nesting starlings, and 8 apparently were used by house sparrows (Passer domesticus). In addition, nests were built in BOPA route boxes by rock wrens (Salpinctes obsoletus) and an unidentified mouse. Kestrels used 2 boxes that had been used by starlings and 1 that had been used by house sparrows earlier in the year. Starlings took over 3 boxes where kestrels had initiated nesting attempts in 1988. Nineteen boxes had no confirmed use by any species during the nesting season.

The Kuna route had the highest kestrel occupancy rate (12 of 30 boxes) and also the highest house sparrow occupancy rate (8 of 30). House sparrows were assumed to have nested in boxes because of the nest material that was present; no eggs or young were present in boxes during our checks. The I-84 Route had the 2nd highest kestrel use rates with 9 of the 30 boxes occupied by kestrels and the highest starling use rates (23 of 30 boxes). All of the I-84 boxes occupied by kestrels were in agricultural or suburban habitat. All 9 boxes in the rangeland between Simco Road and Boise were occupied by starlings. Only 1 pair of kestrels nested along the abandoned power line within the Birds of Prey Area. No starling use of the BOPA route was documented in 1988.

Ten boxes were used by kestrels for the first time in 1988. Kestrels used 7 boxes where kestrels had nested successfully in 1987 and 5 boxes where nesting attempts had failed in 1987.

Nesting success of 22 kestrel pairs in 1988 was 50%, and success rates were similar on the I-84 and Kuna routes (44% and 50%, respectively). The 1 nest on the BOPA route was successful. Clutch sizes ranged from 3 to 5 and averaged 4.5 (n = 19; s.d. = 0.7). These figures do not include 2 nests where only 1 egg was found, and the clutch was considered to be incomplete. Number of young raised per successful attempt ranged from 1 to 5 and averaged 3.1 (n = 9; s.d. = 1.6). Eight of the 11 successful nests experienced some loss of eggs or nestlings. Postfledging mortality also occurred at 1 box. Five of the successful nests fledged fewer than 3 young, and 6 fledged fewer than 4. Most nest failures occurred before hatch (7 of 8 in which time of failure was known), but most losses at successful nests occurred during the brood-rearing stage (3 of 4 nests where timing of losses were known). Five of the 6 successful nests along the Kuna route were in close proximity to residences and manicured lawns, whereas only 1 of the 6 unsuccessful nests was near a home and lawn.

We banded a total of 48 kestrels in 1988 (31 nestlings and 17 adults). of the adults banded, 12 were females and 5 were males. Two different adult females were captured at 1 site (I-84 Box 5). We did not capture any birds that were already wearing bands. We captured adults at 3 boxes (a female at I-84 Box 17 and males and Kuna Boxes 1 and 101) where adults had been banded in 1987. In each case, the individual was different than the individual encountered in 1987.

Weights of adult females ranged from 112 to 168 g and averaged 135 g (n = 12; s.d. = 15). The lightest female was captured while brooding small young; the lightest incubating female weighed 120 g. As in 1987, incubation weights of successful females were lower than those of unsuccessful ones. Weights of females at successful nests averaged 129 g (n = 3) while those at unsuccessful nests averaged 146 (n = 5). The 4 heaviest females did not produce young that fledged. Weights of adult males ranged from 106 to 111 g and averaged 109 g (n = 5; s.d. = 2).

PLANS FOR NEXT YEAR:

Pellets and prey remains collected from boxes occupied by kestrels will be analyzed by a contractor in 1988. In addition, habitat data will be analyzed to assess factors influencing occupancy rates. Monitoring of occupancy, nest success rates, and site fidelity will continue in 1989.

ACKNOWLEDGMENTS

We thank K. Engel, L. George, C. Harris, L. Langelier, W. Melquist, J. Skinner, and K. Skinner for assistance with nest checks. The National Geographic Society donated a ladder to the study. We are especially indebted to the landowners in the Kuna area who graciously allowed us to set up and check boxes on their property.

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TITLE: Feeding Ecology of the Common Barn-owl in the Snake River Birds of Prey Area.

INVESTIGATOR: Carl D. Marti, Department of Zoology, Weber State College

COOPERATOR: Weber State College

OBJECTIVES:

1. Determine food habits and other food niche parameters of nesting common barn-owls (Tyto alba).

2. Determine food niche variation (a) among sites and (b) among years.

3. Determine the barn-owl's position in the raptor feeding guild.

INTRODUCTION

Field studies for this project began in 1978 and have continued through 1988. All data reported here were obtained in the Snake River Birds of Prey Area (BOPA) which is described in U.S. Dep. Inter. (1979). Analysis and subsequent statistical treatments were done at Weber State College, Ogden, Utah. Reports on previous years are also available (Marti 1979, 1981, 1982, 1983, 1984, 1985, 1986, 1987).

This report summarizes field activities and preliminary analysis for 1988 data and provides an overview of yearly changes in dietary composition. An index to trends in barn owl numbers in the BOPA is continued from previous years.

ANNUAL REPORT

I published an analysis of 8 years of dietary data from the BOPA (Marti 1988). That paper described the food niche of the barn-owl during the breeding season, examined both between-year and within-year variation in food-niche dimensions, and compared the food niches of the BOPA barn-owl population with another barn-owl population in Utah.

Three visits were made to the BOPA to collect data in 1988: 22-24 April, 28-30 May, and 1-2 July. I collected 18 samples of regurgitated pellets from 7 sites (Table 1). A summary of the prey content of these pellets is in Table 2.

Among major prey, Microtus and Mus decreased in dietary frequency compared to 1987. Compensatory increases in the frequencies of Peromyscus, Dipodomys, Perognathus, and Thomomys were observed. Other minor prey types changed very little from 1987. Fig. 1 presents yearly trends in dietary frequencies of major barn-owl prey genera.

Table 1. Collection sites for common barn-owl food habits data in the BOPA, 1988.

Mary's
Jensen Cliff
Castle Rock
Lower Lower Black Butte
Upper Lower Black Butte
Road End
Chattin Hill

Table 2. Total prey identified for the common barn-owl in the BOPA, 1988.

Prey Species	Number	Percent Number
MAMMALS		
Sorex vagrans	15	0.4
Mus musculus	273	7.7
Peromyscus spp.	445	12.5
Reithrodontomys megalotis	184	5.2
Onychomys leucogaster	1	tr.
Microtus montanus	1788	50.3
Neotoma lepida	6	0.2
Neotoma cinerea	2	tr.
Perognathus parvus	299	8.4
Dipodomys ordii	265	7.5
Thomomys townsendii (juvenile)	220	6.2
Spermophilus townsendii	2	tr.
unidentified leporids (neonate)	4	0.1
BIRDS		
Sturnella neglecta	1	tr.
Sturnus vulgaris	9	0.2
unidentified icterid	5	0.1
unidentified medium bird	6	0.2
unidentified small bird	27	0.8
Totals	3552	100

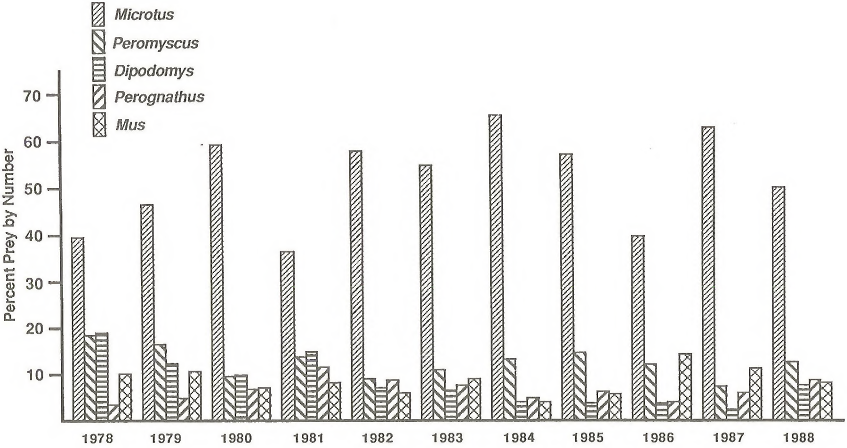

Fig. 1. Yearly trends in major prey genera of the Common Barn-Owl in the Snake River Birds of Prey Area.

The apparent decline in number of nesting barn-owls noted in 1986 and 1987 may have reversed slightly in 1988. Seven of 15 traditional nest sites were occupied, and nesting was verified at 5. Data from 1988 are compared to other years in Table 3. Data were gathered under the same protocol and with approximately the same degree of effort in each year. Thus, they may serve as an index to the relative number of barn-owls occupying the BOPA. Some population changes in other small- and medium-sized, rodent-eating owls were noted in 1988. Short-eared owls (*Asio flammeus*), common in 1987, were rarely observed in 1988. Northern Saw-Whet Owls (*Aegolius acadicus*) apparently did not breed in the BOPA in 1988 (J. Doremus and J. Marks, pers. commun.).

PLANS FOR 1988

Three trips to the BOPA are planned for the spring/summer of 1989. The goals for 1989 are to continue collecting food habits data for the analysis of long-term predation trends by barn-owls and to monitor trends in breeding numbers.

ACKNOWLEDGMENTS

I thank Michael Kochert, Karen Steenhof, John Doremus, Jeff Marks, Lenny Young and all of the Snake River Birds of Prey Research staff for a variety of assistance in carrying out this study. The Bureau of Land Management provided a vehicle for field use and living space in field camps. Weber State College provided a Faculty Research Grant covering travel to the study area from Ogden, Utah, and laboratory space and computer facilities for data analysis.

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Table 3. Comparison of pellet collection data from nest sites of common barn-owls in the BOPA.

	Year of Collection									
	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
Number of occupied sites	15	13	25	16	16	19	15	5	4	7
Number of pellet collections	33	18	38	22	28	33	26	11	8	18
Total number of prey identified	5426	3326	5359	5074	4142	7475	5559	996	1451	3552
Number of visits for collection	3	3	3	2	3	3	3	2	2	3

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TITLE: The Use of Nest Boxes, Reproduction, Movement, Food Habits, and the Annual Cycle of Body Mass of Western Screech Owls in the Snake River Birds of Prey Area

INVESTIGATORS: John Doremus, Wildlife Biologist, Boise District, BLM
Jeffrey Marks, University of Montana, Missoula, Montana

OBJECTIVES: To determine patterns of nest box use, fidelity to site and mate, reproductive success, and the annual cycle of body mass in western screech-owls (*Otus kennicotti*).

METHODS

Thirty-two locations (a location is a position or site occupied by or available for occupancy) with at least 2 boxes per location (Table 1), were available as roosting/reproduction locations for western screech-owls in the study area in 1988. All locations were visited at least once a month, January through April and November and December. Known breeding locations were visited in May to band the nestlings. During each visit (excluding incubation and brooding sites) we collected prey remains and pellets, banded all unbanded owls, and recorded the body mass of all owls encountered. The length of primary 8 was measured on all adult size owls encountered. The sex of adult owls was determined during the breeding season by the presence or absence of an incubation patch. The birds encountered between November and April could be aged by the color of the underwing. Birds less that 1 year of age have a buffy color on portions of the primaries, secondaries, and greater wing coverts. Birds older than one year have a pinkish wash on their new primaries, secondaries, and greater wing coverts.

The nest boxes were not visited frequently enough to determine the number of eggs laid or hatched or the number of young fledged.

RESULTS AND DISCUSSION

Western screech-owls were found at 21 locations during 1988, 14 of the locations were not used during the breeding season. Three of the locations were occupied during the breeding season, but no evidence of a breeding attempt was found at these locations. All four breeding locations were successful at hatching young. The Delta East location had not initiated laying until after the 9 April visit. No visits were made to this location during the incubation or brood rearing period. At banding 1 nest contained 3 young, 1 nest contained 4 young, and 1 nest contained 6 young. (mean=4.33, SD=1.70).

We banded 23 screech-owls during 1988 (13 nestlings, 3 HY and 7 adult owls). We have now banded 148 western screech-owls (84 nestlings and 64 adult size owls) since 1980. During 1988 we encountered 3 adult size owls, for the first time, that we had banded as nestlings (Table 2)

We obtained 42 weights from 27 adult sized owls (10 female weights 6 male weights and 26 weights from owls of unknown sex). Female weights ranged

Table 1. Location names and occupancy status at roosting/nesting boxes available to western screech-owls in the Snake River Birds of Prey Area in 1988.

Location name	Status	Nesting success
Black Butte, Lower Lower	vacant	
Black Sands III	vacant	
Bruneau Boat Launch	vacant	
Bruneau Marsh	roosting	
Bruneau Marsh North	roosting	
Bruneau Marsh South	vacant	
Bruneau Marsh West	roosting[a]	
Bruneau Rest Stop	vacant[b]	
Cabin, Lower	breeding	unknown success
Cabin, Upper	vacant[b]	
Castle Creek Mouth North IV	breeding	unknown success
Cellar Hole	roosting	
Crane Falls Sturgeon	roosting	
Delta East	breeding	unknown success
Delta South	vacant	
Delta West	vacant	
Dunes Entrance pond	breeding	unknown success
Flat Iron Marsh	vacant	
Harris	roosting[b]	
Jacks Creek	roosting	
Little Valley School	roosting	
Loveridge Bridge	vacant	
Orcutt Treeline	roosting	
Rabbit Springs	vacant	
River Road	roosting[b]	
Strike Camp	roosting	
Strike Dam	roosting[b]	
Strike Reservoir	roosting	
Strike Camp Treeline II	roosting	
Three Forks	roosting[a]	
Tom Draw	roosting	
Two Forks	roosting[a]	

[a] Western screech-owls present during the nesting season but not nesting in the boxes.
[b] American kestrels nesting in box.

Table 2. Western screech-owls banded as nestlings and recaptured for the first time as adult size birds in the Snake River Birds of Prey Area in 1988.

Band Number	Birth Site (date banded)	Recapture Site (date recaptured)	Distance (km.)
865-37590	Strike Reservoir (10 May 87)	Crane Falls Sturgeon (24 Jan 88)	12.1
795-43986	Cellar Hole (28 May 84)	Strike Camp Treeline II (11 Nov 88)	33.4
795-43941	Cabin Draw (07 May 88)	Tom Draw (07 Dec 88)	14.2

from 187-297 gm. Male weights ranged from 180-215 gm. The weights of the unknown sex owls ranged from 158-258 gm. The female that weighed 297 gm. was weighed during laying and she had an egg in her oviduct when weighed.

American kestrels (Falco sparverius) nested in boxes at 5 locations (Table 1).

TITLE: Thermoregulation in Nestling Owls: Its Development and Implications.

INVESTIGATORS: Leslee D. Singer, Graduate Student, Idaho State University
Charles Trost, Professor, Idaho State University

COOPERATOR: Idaho State University

OBJECTIVES:

1. To determine the body mass at which an endothermic state is achieved, the rate of development of behavioral thermoregulation, and the rate of feather development in relation to body mass, age, and attainment of an endothermic state.

2. To determine the minimal brood size at which a collective endothermic state can be attained and maintained, and the rate of development of behavioral thermoregulation.

3. To evaluate and compare the possible ecological significance of brood size, body size, minimum clutch size, rates of weight gain, feather development rate, age when thermoregulation is achieved, breeding season, and nesting habits in open and cavity nesting species.

4. To evaluate and compare the different nesting habits for ambient nest temperatures as compared to external temperatures, nest orientation and prevailing wind correlations, nest composition, and modification of nest temperature by nestling owls.

INTRODUCTION

A variety of growth and developmental studies have been conducted on the establishment of homeothermy from a poikilothermic state in a number of nestling avian species. Studies to date, however, have essentially concentrated on small altricial passerine species. In this study, raptors of the family Strigidae (Owls) were studied in an attempt to document the establishment of thermoregulation in the semi-altricial young of several species. Specifically, open and cavity nesting species were examined to compare and analyze differences in growth rate, attainment of thermo-homeostasis, and associated advantages/disadvantages offered by contrasting nest sites.

RESULTS

The results of this study were reported in a Master's thesis completed in May 1988. A summary of the thesis follows:

1. In this study the development of homeothermy for 4 species of the family Strigidae (Owls) was documented to determine at what point in the nestling cycle homeothermy is attained.

2. Northern saw-whet owl, (Aegolius acadicus) nestlings achieved homeothermy between 13-15 days of age, at a weight of 70-79, and when approximately 93.5% down covered. Nestlings experienced a drop in relative growth rate from 16.7%-6.4% upon attainment of homeothermy and exhibited accompanying changes in thermoregulatory behavior as well.

3. Western screech-owl (Otus kennicottii) nestlings also achieved homeothermy at a weight of 70-79 but at 8-10 days of age and with 98.2% down coverage. They experienced a decrease in relative growth rate upon attainment of homeothermy from 16.6% to 8.3%, and also exhibited changes in thermoregulatory behavior.

4. Long-eared owl (Aslo otus) nestlings achieved homeothermy at a weight of 150-159 and 11-12 days of age. Nestlings were 96.9% down covered, experienced a decrease in relative growth rate from 19.3% to 2.4% upon attainment of homeothermy and concurrently exhibited changes in thermoregulatory behavior indicative of a homeothermic state.

5. Great horned owl (Bubo virginianus) nestlings achieved homeothermy at an age of 12-14 days and within a weight range of 300-349.

6. Only the northern saw-whet owl appeared to fit Lohrer's suggested pattern for Owls for the attainment of homeothermy at midpoint in the nestling cycle and at three-fourths of adult body weight. The other 3 species fit a more common pattern among altricial species in which the point of attainment in the nestling cycle and corresponding weight achieved at homeothermy vary, depending upon intra-specific growth rates.

7. The 4 species observed did not display an ability, as a collective brood, to thermoregulate at an earlier age than individuals. This is in contrast to a pattern seen in many altricial species, and can in all probability be attributed to their asynchronous egg laying and hatching strategy.

8. Nest boxes were selected at random regardless of nest entrance orientation to prevailing winds. This was attributed to the natural scarcity of suitable nesting sites in the study area and the resultant willingness to accept less than ideal sites for nesting purposes.

9. Internal nest box temperatures of occupied boxes were not significantly different than external ambient temperatures. Results probably stem from the relatively mild ambient temperatures experienced.

TITLE: Post-nesting Ecology of Long-eared Owls in the Snake River Birds of Prey Area, Idaho.

INVESTIGATOR: Helen M. Ulmschneider, Boise State University

COOPERATOR: Boise State University

OBJECTIVES:

1. To determine the timing, distances, and directions of movements of Long-eared Owls when they leave their nest groves.

2. To characterize roost sites.

3. To determine whether adult and juvenile hunters select different prey.

INTRODUCTION

Long-eared Owls breed in the Snake River Birds of Prey Area (BOPA) from March to June (Marks 1986). The owls then seem to disappear from the region and no one knows where they go. The basic objectives of this 2-year study is to discover the pattern of the owls' movements when they leave and, if possible, where they go. Secondary objectives are (1) to characterize roost sites, and (2) to determine whether or not there are differences in prey selection between adults and juveniles.

METHODS

Radio-tracking. In mid-May, when the owlets were 4-5 weeks old, I trapped adult owls at 4 nest sites (Table 1) using mist nets. I attached single-stage transmitters (Biotrack, Wareham, Dorset, England) with an elastic backpack harness to 2 adult male, 4 adult female, and 5 juvenile owls (Table 1). The package weighed 10 g, which was < 4% of an owl's body weight. I also marked all members of a family with either red or white colored plastic leg bands to aid in identification. Signal range was at least 5 km on the ground, and 25 km from the air, using a Telonics TR-2 receiver and omni and H-antennas.

I checked nest groves every 1-2 days. When an owl was missing, I immediately began searching the surrounding area by truck, visiting tree groves and high spots within a 10-30 km radius. I continued searching for all missing owls wherever I went on subsequent days. When ground searches proved fruitless, I searched from the air in a Cessna 205 equipped with 2 H-antennas mounted on the wing struts. Additional aerial searches were donated by BLM and Idaho Fish and Game biologists in the course of their bighorn sheep study, and a helicopter flight was donated by the BOPA research team during their raptor nesting surveys.

Night watches. To track the development of hunting and flying abilities of the young, I conducted night watches at the nest groves. Each site was

Table 1. Nest sites of radio-tagged Long-eared Owls in the Snake River Birds of Prey Area, Idaho, 1988.

Site Name	Radio-tagged male	Radio-tagged female	Radio-tagged juvenile	Total Fledged
Strike Dam Marsh Green	1	1	0	0
Strike Dam Road	1	1	1	2
Nicholson Pond South	0	1	2	5
Bruneau Arm	0	1	2	5
Total	2	4	5	12

monitored twice a week from dusk to 0100-0200 hrs. During a night watch I recorded presence and activity of all radioed owls. Activities included food begging, flying, and visits by adults.

Roost sites. For each radioed bird, I located exact roost perches at least once a week. I also recorded roosts used by unradioed long-eared owls. I attempted to find roosts without flushing the owl, and would return later to take measurements. Sketches of the roost site and the position of whitewash and pellets helped me relocate exact perches.

At a roost site, I recorded roost tree species, height, and diameter at breast height; roost height, distance to closest edge, distance from tree trunk, and cover values. Cover was rated on a scale of 1-4 in each of 4 directions plus overhead from the roost, with "1" being < 25% cover and "4" being > 75% cover. I also measured the length and width of roost groves and recorded tree species and their average size category (<5 cm dbh, 5-10 cm dbh, and >10 cm dbh).

Food Habits. I collected pellets throughout the season, recording roost site and what owl(s) used it, if known. Pellets were analyzed by soaking them in a 10% solution of NaOH to dissolve the hair, and using skulls, dentaries, or for larger species, long bones to identify species and numbers of prey items. Within a sample of pellets, I recorded the number of a prey species as the number of skulls, right or left jaws, or (for lagomorphs, *Thomomys*, and *Dipodomys*), right or left femurs, humeri, or tibia-fibulas, whichever was greatest.

RESULTS

Night watches. The data from night watches are still being analyzed, but here is a general summary of the changes in fledgling behavior after branching. At first, the newly branched young food-begged steadily from the same tree, only moving a bit from branch to branch with short hops and using their beaks to aid climbing. Within 2-3 weeks, they could fly from tree to tree along the nest grove, and food beg from different spots. Approximately 5 weeks after branching, I recorded fledglings making flights of from 5-20 min away from the nest grove. The radio signal indicated when an owlet was flying: it fluctuated with every beat, its direction changed and the overall volume varied. The owlets would then return to the nest grove and food beg.

During the last week, or about 7 weeks after branching, the owlets would not always stay in the nest grove to food beg, but moved out into surrounding fields. I sometimes had to walk as much as 2 km out into the fields, following radio signals, before locating the young scattered about sitting on the ground, food begging. They changed positions frequently and flew about. Since the adult females were gone by this time, and I had only one successful adult male radioed, it was difficult to determine how much the young were being fed by adults.

Movements. The majority of owls roosted in their nest grove every day until suddenly departing, and never being found again, despite intensive search. Table 2 and Figure 1 show the dates owls left their nest groves. Adult females left first, followed by most of the juveniles 2-3 weeks later, with adult males staying the longest.

Table 2. Tracking history of radio-tagged Long-eared Owls in the Snake River Birds of Prey Area, Idaho, 1988.

Site	Sex/ Age	Date Tagged	Date first left nest grove	Date last located	Total days Tracked*
SDM	F	15 May	17 May	22 May	8
BA	F	19 May	6 June	8 June	21
SDR	F	27 May	7 June	22 June	27
NPS	F	14 May	9 June	8 June	26
SDR	J	16 June	23 June	22 June	7
BA	J	20 May	25 June	24 June	36
NPS	J	14 May	27 June	26 June	44
BA	J	19 May	30 June	29 June	42
NPS	J	18 May	9 July	8 July	52
SDR	M	27 May	26 June	25 June	30
SDM	M	15 May	22 May	3 Sept	112

SDM - Strike Dam Marsh Green (failed nest)
BA - Bruneau Arm
SDR - Strike Dam Road
NPS - Nicholson Pond South
F - adult female
M - adult male
J - juvenile (sex unknown)

* "Total days tracked" = number of days from day radio-tagged through last day located.

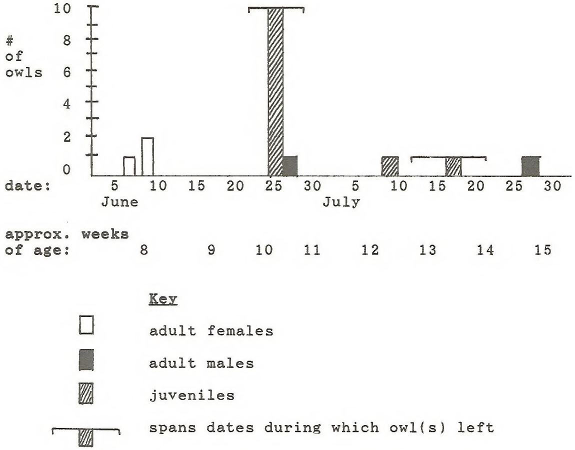

Figure 1. Dates Long-eared Owls left their nest groves in the Snake River Birds of Prey Area, Idaho, 1988.

Three adult females left their nest groves on 7 and 9 June. This corresponded to the time the young were beginning to make flights away from the nest grove. The Nicholson Pond South female left on 9 June and I never found her again.

The Bruneau Arm female first left on 6 June and roosted 1.5 km south of her nest grove for at least one day. She then returned to her nest grove before leaving on 9 June. I never found her again.

The Strike Dam Road female left her nest grove on 7 June and began roosting 2.5 km to the north, near Nicholson Pond. She apparently did not return to her nest grove, as I never again got her signal there. She stayed for 2 weeks at Nicholson Pond, except for once when I found her 6 km to the southwest along the river. On 24 June she disappeared, and I never found her again.

Most of the juveniles (10 of 12) left 2 to 3 weeks after the females, between 22 and 30 June. They did not seem to leave as groups, but rather one at a time. For example, at Nicholson Pond South I recorded 5, then 3, then 2, then 1 juvenile between 22 and 28 June.

A few owls remained at their nest groves 2-4 weeks longer than the rest of their families- all of these being juveniles or males. These were: a juvenile and the adult male (both unradioed) at Bruneau Arm, and a juvenile (radioed) and possibly the adult male (unradioed) at Nicholson Pond South. The last 2 juveniles disappeared between 10 and 21 July.

One male, from Strike Dam Road, left on 26 June during the time when most of the juveniles disappeared. The unradioed male from Bruneau Arm left his nest grove a month later during 24-27 July. I am not sure when the unradioed male from Nicholson Pond South left. However, I found fresh pellets on 21 July, in a roost site I had previously suspected he used.

The last bird to disappear was the male from Strike Dam Marsh Green whose nest had failed. He had left his nest site on 22 May, a week after the young were depredated. He moved a few miles at a time up the Snake River arm of C.J. Strike Reservoir, until he stopped at Crane Falls Lake, about 12 km from his nest site. He remained there until 3-9 Sept., when I lost him too. His mate had also left the nest site on 22 May, and I never found her again.

Searches. During June and July I covered the Snake River and local tributaries from King Hill to Murphy repeatedly, looking for lost owls. I drove likely roads scanning for signals, and also stopped and hiked to high points to listen for signals. I boated those stretches of the canyon without roads. I also drove into the mountains to the north and south of the Snake River Plains, following major drainages into the Owyhees to the south, and visiting 3 lookouts along the northern front range.

I searched a larger area from the air. On 7 June I searched for the first lost owl, the female from Strike Dam Marsh Green, from a helicopter. We flew the Snake River Canyon from Rabbit Creek to Glenn's Ferry. I also searched from a Cessna 205 several weeks after most of the owls had departed. We flew 4 times during July and August for a total of 18 hrs. We flew at an altitude of 3600 m where I could pick up radio signals from known

owls at 25 km. We flew lines parallel to the lay of the mountains, 15-25 km apart. We covered SW Idaho from the south side of the Owyhees north to a line from Weiser to Fairfield, and from the Oregon border on the west to Big Jack's Creek on the east. We flew the Snake River itself from Weiser to Pocatello, then west along the Idaho-Nevada border to the Jarbidge Mountains, then down the Jarbidge River to the Snake.

BLM and Fish and Game biologists also scanned for my owls during flights from Boise along the Snake River to Jack's Creek during June and July.

None of these searches yielded signals from any lost owl. It is possible that I missed birds, but I doubt that I would have missed all 10 birds if they had been in the SW Idaho area.

My data suggest the Long-eared Owls leave their nest areas suddenly and that they go a long way at once. They seem to leave southwestern Idaho completely. Females appear to leave before the young are completely independent, and males seem to stay near the nest territory longer than either females or juveniles.

Roost Sites and Food Habits. These data are being analyzed. After a second field season, they will be reported in a Master's thesis at Boise State Unviersity.

I have identified 639 prey items so far, (Table 3), which contained a greater proportion of juvenile Thomomys than previously reported by Marks (1984).

Plans for next season. Overall, my second season will follow the pattern of the first. I intend to change from single-stage to two-stage transmitters, because they will have over twice the range. They will last 2.5-3.5 months, and this will be sufficient for tracking the first stages of the owls' movements. Judging from last season, I may not be able to determine where the owls go, but I hope to discover their initial directions and distance of movement, and confirm whether they leave southwestern Idaho.

During last season's night watches, it seemed that the females made fewer visits to the young. I would like to pursue this further, comparing the relative number of prey deliveries by males and females over the course of the nesting cycle.

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Table 3. Number and percent of prey items in Long-eared Owl pellets from 2 sites in the Snake River Birds of Prey Area, Idaho, April-June, 1988.

	Strike Dam Marsh		Castle Mouth North		Total	
	#	%	#	%	#	%
Peromyscus	195	41	42	26	237	37
Microtus	103	22	1	0.6	104	16
Perognathus	14	3	76	47	90	14
Dipodomys	76	16	10	6	86	13
Mus	36	8	0	0	36	6
Reithrodontomys	23	5	6	4	29	4.5
Thomomys juv.	7	1	21	13	28	4.4
Lagomorph juv.	11	2	5	3	16	2.5
Bird	6	1	1	0.6	7	1
Neotoma	5	1	0	0	5	0.7
Sorex	1	0.2	0	0	1	0.2
	477		162		639	

* Pellets collected from 3 other sites are still being analyzed.

TITLE: Home Range and Habitat Use of Ferruginous Hawks in the Snake River Birds of Prey Area

INVESTIGATORS: Dr. Marc Bechard, Dept. of Biology, Boise State University
Dawn McAnnis, Dept. of Biology, Boise State University
Nancy Stotz, Dept. of Biology, Northern Arizona University

COOPERATOR: Dept. of Biology, Boise State University

OBJECTIVES:

1. To determine home ranges of nesting male ferruginous hawks

2. To determine habitat use within home ranges

3. To determine effects of range fires on home range size and habitat use

INTRODUCTION

The increased frequency of wildfires in southwestern Idaho over the past decade has greatly changed the habitat composition of the Snake River Birds of Prey Area (SRBOPA). Historically the soils, prey density, and vegetation combined to create a unique environment supporting an unusually high density of nesting raptors. Since 1980 over 50% of the native shrub habitat has been destroyed and converted to annual and perennial grassland (Kochert and Pellant 1986). The effects of this habitat perturbation on raptors have yet to be fully determined. The ferruginous hawk (Buteo regalis) is the largest and most specialized Buteo nesting in semi-arid regions of western North America (Schmutz 1987). It is considered sensitive to disturbances in its nesting areas and habitat disturbance due to agriculture has been indicated as a serious threat to its status (Howard 1975, Thurow et al. 1980, Cottrell 1982, Gilmer and Stewart 1983, Schmutz 1984). The effects of increased fire frequency on ferruginous hawks are largely unknown, but evidence indicates fires may reduce the availability of rodent prey in burned habitats (Groves and Steenhof 1988). Research is needed on the habitat use of ferruginous hawks nesting in shrub-steppe areas that have been burned to determine the extent to which wildfires are impacting this species.

METHODS

Four study nests were chosen based on the maximum amount of habitat heterogeneity within a 4-km radius of the nesting area (Fig. 1). The size of this area was chosen based on previous observations of ferruginous hawk home ranges by Wakeley (1978). Availability of at least 20% native shrubs and 20% grasses within the territory as determined using Department of Water Resources 1987 vegetation maps was chosen as the minimum degree of acceptable heterogeneity.

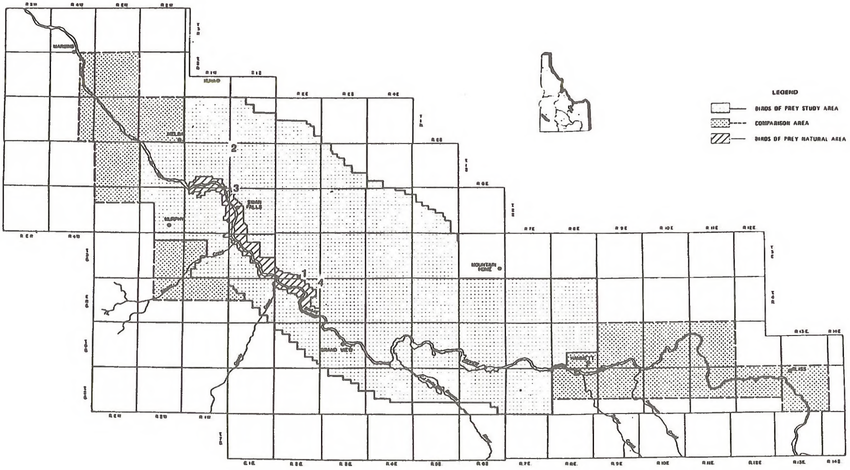

Fig. 1 Location of ferruginous hawk study nests within the BOPA. Number 1 indicates Powerline male, 2 is PP&L 113/3 male, 3 is Big Baha 221 male, 4 is Big Baha 92.

In March, each nesting territory was monitored to determine its occupancy. When nests had young at least 1 week of age in mid-May, males were trapped using a dho-gaza net (Bloom 1987) placed near the nest with a live Great Horned Owl (Bubo virginianus) for bait. Birds were fitted with 15-g Telonics (Mesa, Arizona) radio transmitters attached to the inner 2 rectrices and were banded with a United States Fish and Wildlife Service leg band. Three of the 4 males were fitted with a bright yellow patagial marker placed on the right wing.

Full day observations on habitat use and foraging site selection began approximately 1/2 hour prior to sunrise and continued to approximately 1/2 hour past sunset. Observations were initially scheduled every other day such that each bird was observed once within an 8-day period, although trapping, inclement weather or illness sometimes caused alterations in the schedule or early termination of the observation period. When a tracking day was missed due to the above reasons, the focal bird was followed at the earliest opportunity (usually the very next day) and the alternate-day schedule was initiated as soon as possible. The shortest interval between tracking days for an individual hawk was 7 days, while the longest interval was 10 days. Radioed hawks were followed visually using a 4-wheel drive vehicle or trail bike, and their activities and habitat use were recorded continuously in a field notebook. Additionally, activity and habitat type information was recorded separately at 5-min intervals, although analysis of these data has not been initiated.

A foraging bout was described as the obvious pursuit of prey such as diving toward the ground while flying, or running after prey while on the ground. Perch locations were recorded separately from foraging locations. New perch locations were recorded if the male moved more than 100 m and/or moved into a new habitat type. Flying locations were not recorded until after the field season. Within 6 weeks of the close of the field season the farthest locations from the nest the hawk was observe while flying (as determined by personal recollection and/or entries in field notebooks) were entered on topographic maps and included in home range analysis.

When a bird flew out of view, it was relocated using telemetry, and observations resumed as soon as possible. As the nesting season progressed males traveled farther from the nest and were sometimes out of sight or radio contact for hours at a time. The greatest temporal gap between visual or radio observations for a single bird was approximately 3 1/2 hours. Tracking was terminated when the male could no longer be found in the study area or when he molted the tail feathers holding the radio-transmitter.

Home ranges were determined using the minimum convex polygon method of Mohr (1947) and were based on all perching and foraging locations, and some of the flying locations. The area within the polygon was measured using an electronic planimeter. Habitats within home ranges were described using the following vegetation categories: native shrub, shrub/grass mosaic, grasses, rehabilitated burned, agriculture, edge and other (Table 1). Vegetation maps used for the analysis were either completed in the fall 1988 by BLM biologists K. Timmerman and A. Herndon, or by D. McAnnis while in the field.

Table 1. Habitat categories used to describe habitat use by nesting ferruginous hawks in the SRBOPA.

Category	Description
native shrub	>80% big sage, winterfat, shadscale, and shadscale/winterfat mosaics
shrub/grass mosaic	consisting of many patches of >50% homogeneous sage or winterfat mixed with patches of <50% grass
grasses	dominated by >80% annuals, though some perennials may be present
rehabilitated burn	dominated by >80% seeded or native perennials
agriculture	includes cultivated or fallow fields and pastures surrounded by cultivated fields
edge	a 1-m zone on either side of a definite edge between 2 habitat types
other	may include bare ground, road, canyon, or unique vegetation type

In order to assess habitat use with respect to availability, a circle was constructed around each nest using the farthest point from the nest that a radioed bird was observed as the radius to determine habitat availability. Each habitat type was then individually cut out from the maps and weighed on an electronic balance to determine the percentage of total available habitats occupied by each habitat type. A Chi-square goodness-of-fit test was used to determine if the habitat composition of the actual home ranges differed significantly from that which was available.

RESULTS

Four male ferruginous hawks were trapped and radio-tagged between 14 May and 25 May 1988 (Fig. 1). A total of 445 observation hours was logged from 15 May through 23 July. The total number of locations per bird ranged from 25 for Big Baha 92 whose nest failed early in June, to 150 for Big Baha 221 male (Table 2). Only the radio-transmitter from Powerline male was recovered.

Home range size averaged 7.26 km^2 (range 4.39 to 11.99 km^2) prior to fledging and thereafter increased as the young became increasingly independent (Table 3). The post-fledging home range increased to an average size of 13.13 km^2 and ranged from 5.71 km^2 for Big Baha 221 to 25.54 km^2 for PPL 113/3. Due to the early failure of the nest of Big Baha 92, a determination of its home range was not possible.

The range of Powerline male consisted 46% grasses, 7% native shrub, 34% rehabilitated burn, 5% shrub/grass mosaic, and 8% unspecified (Fig. 2). The range of PPL 113/3 did not contain any rehabilitated burned habitat, but contained large amounts of native shrub (34%), shrub/grass mosaic (17%) and grassland (33%) (Fig. 3). The range of Big Baha 221 consisted of 55% grass, 2% native shrub, 39% rehabilitated burn, and 4% shrub/grass mosaic (Fig. 4). A Chi-square goodness-oft est revealed no significant difference between percent composition of habitat types within the hypothetical circular home range and the actual home range for any bird (Table 4).

Fifty percent (n=177) of all observations of perched and hunting birds occurred in grass habitats. Eighteen percent (60), 16% (49), and 16% (47) occurred in native shrub, rehabilitated burned and shrub/grass mosaic habitats, respectively (Table 5). Powerline was observed perched on 56 occasions, 82% (n=46) of which were in rehabilitated burned areas, 16% (9) in grassland, and <2% (1) in native shrub. Compared to its availability, this bird disproportionately used rehabilitated burned areas and avoided grasses and native shrub habitat (X^2 = 43.6446, P = 0.0001).

Forty-four percent (n=55) of perching and hunting locations for PPL 113/3 were in native shrub, 34% (42) were in shrub/grass mosaic, 8% (11) were in grassland, 6% (8) were in agriculture, and 6% (8) were in edges between habitats. In mid-June, 1988, a range fire consumed 7% of this bird's native shrub (big sage) habitat. Based on the proportions of the 6 habitat types within the home range, PPL 113/3 used native

Table 2. 1988 Tracking history of all radio-marked ferruginous hawks

Subject bird	Marking Date	Wingtag	Last Tracking Day	Total* # Days Tracking	Total* # Hours Tracking	Total # Locations
Powerline	15 May 1988	none	5 July 1988	7	100	56
PPL 113/3	18 May 1988	# 1	23 July 1988	9	135	123
Big Baha 221	25 May 1988	# 3	11 July 1988	6	90	150
Big Baha 92	25 May 1988	# 2	23 June 1988	4	62	25

*Only tracking days when at least one radio signal was heard from the subject bird were included

Table 3. Pre- and post-fledging home range sizes of ferruginous hawks nesting in the SRBOPA.

	Pre-fledging	Post-fledging*
Powerline	5.39 km^2	8.14 km^2
PP&L 113/3	11.99 km^2	25.54 km^2
Big Baha 221	4.39 km^2	5.71 km^2

*Post-fledging home range size was determined by extending pre-fledging home range with any post-fledging locations

Table 4. Percent composition of habitat types in ferruginous hawk home ranges.

Habitat type	Powerline	PP&L 113/3	Big Baha 221
grasses	46% (24%)*	33% (46%)	55% (27%)
native shrub	7% (24%)	34% (33%)	2% (17%)
shrub/grass mosaic	5% (8%)	17% (4%)	4% (2%)
rehabilitated burn	34% (25%)	--- (4%)	39% (42%)
agriculture	--- (4%)	8% (6%)	--- (2%)
other	8% (15%)	--- (2%)	--- (10%)
1988 burn	--- ---	7% (5%)	--- ---

*() parentheses indicate percent composition of habitat types in home ranges as determined by drawing a circle around the nest using the farthest point from the nest that a radioed bird was observed

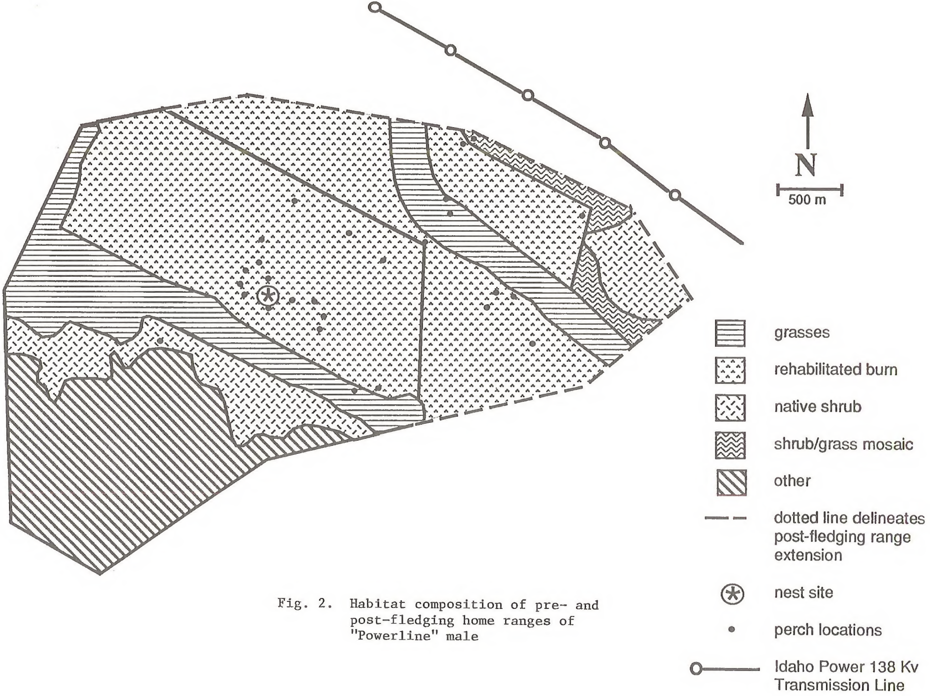

Fig. 2. Habitat composition of pre- and post-fledging home ranges of "Powerline" male

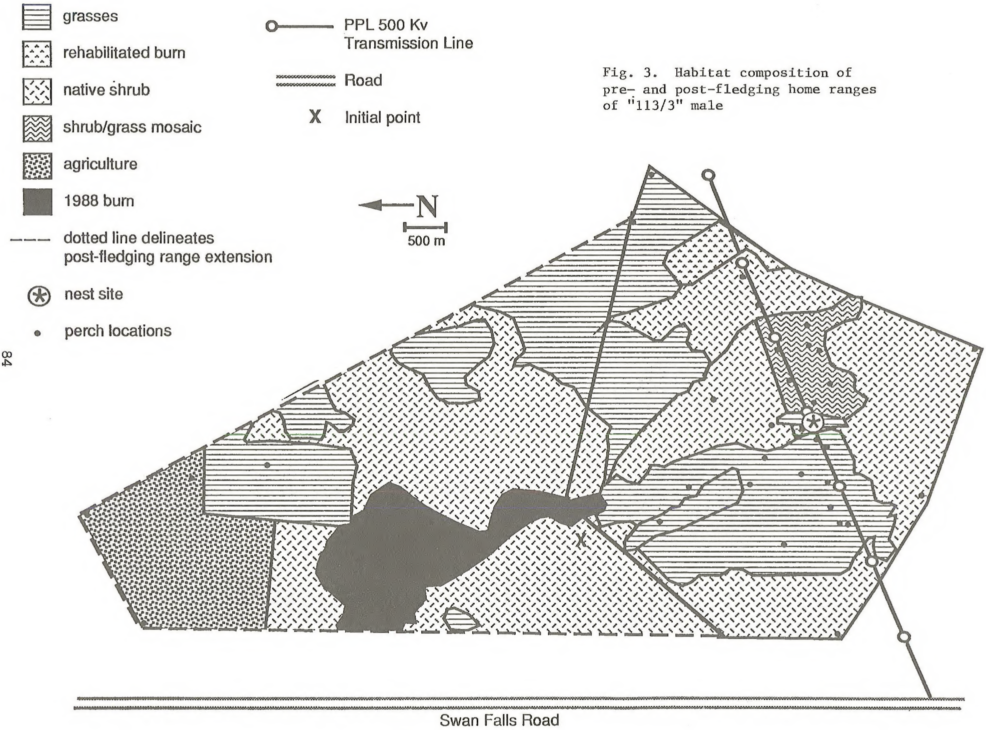

Fig. 3. Habitat composition of pre- and post-fledging home ranges of "113/3" male

Fig. 4. Habitat composition of pre- and post-fledging home ranges of "Big Baha 221" male

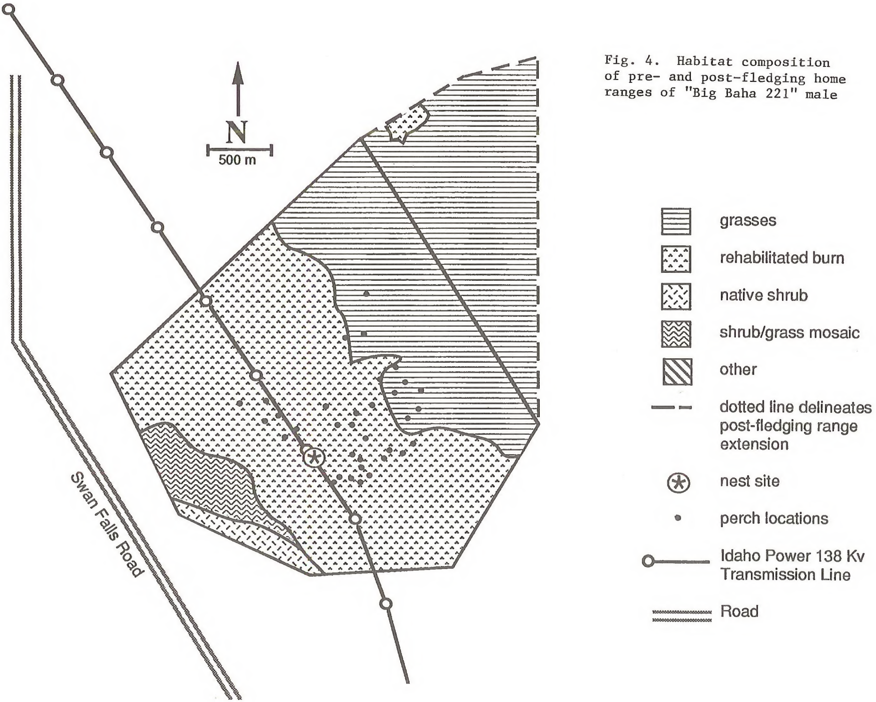

Table 5. Habitat use of ferruginous hawks nesting in the SRBOPA.

habitat type	% availability	#locations	% of total locations
<u>Powerline</u>			
native shrub	7%	1	1.78%
shrub/grass mosaic	5%	---	-----
grasses	46%	9	16.1%
rehabilitated burn	34%	46	82.1%
other	8%	---	-----
<u>PP&L 113/3</u>			
native shrub	34%	55	44.7%
shrub/grass mosaic	17%	42	34.1%
grasses	33%	11	8.9%
agriculture	8%	8	6.5%
'88 burn	7%	---	-----
<u>Big Baha 221</u>			
native shrub	2%	3	2.0%
shrub/grass mosaic	4%	7	4.7%
grasses	55%	133	88.7%
rehabilitated burn	39%	3	2.0%

shrub and shrub/grass mosaic habitats more frequently than the other habitats available (X^2 = 46.1119, $\underline{P}$ = 0.0001).

Big Baha 221 was found perching or hunting on 150 occasions. Of these, 133 (89%) were in grassland, 7 (5%) were in shrub/grass mosaic, and 3 were in native shrub and edge habitats (4%). This male showed a significant preference for grassland types and avoidance of rehabilitated burned and native shrub habitats (X^2 = 85.9171, $\underline{P}$ = 0.0001).

Big Baha 92 was observed perching on only 25 occasions (Fig. 5). Twenty-four (96%) perches were in grasses. This male was observed perching once in native shrub (shadscale).

Home range size was negatively correlated with the percentage of habitat historically disturbed by fire and now consisting of grasses or rehabilitated burned areas (Table 6). The bird with the smallest home range had the greatest percentage of historically burned habitat within its home range (94%), whereas PPL 113/3 with the largest home range had the least amount of burned habitat within its range.

DISCUSSION

The average pre- and post-fledging home range sizes of male ferruginous hawks nesting in the SRBOPA were found to be 7.26 and 13.13 km^2. Home ranges increased for all males after young fledged. Except for 1 male, home ranges of ferruginous hawks nesting in the SRBOPA were smaller than those cited by Wakeley (1978) who found ranges to be 17 km^2 and 21 km^2 in shrub-steppe habitats of Utah.

Home ranges consisted of varying amounts of burned habitat (now dominated by exotic annuals, perennials, or rehab seedings). The bird with the smallest home range size had the greatest proportion of burned habitat within that range, while the bird with the largest home range had a home range composed of more than 50% native shrub and shrub/grass associations. Based on these 3 birds it appears that burning of the available habitats may decrease range size.

None of the 3 males were observed to select habitat types within their home ranges in proportion to their availability. Powerline and Big Baha 221 males occupied home ranges consisting of 80 and 94% grassland or rehabilitated burned areas respectively. These birds also significantly concentrated their use in these habitats. PPL 113/3, on the other hand, occupied a home range consisting of more than 50% native shrub, shrub/grass mosaic, but only 34% grasses, appeared to avoid grassland for perching and foraging areas.

Newton (1979) found sparrowhawk (Accipiter nisus) ranges to be smaller in areas of high prey densities, and larger in areas with few prey. One effect of fire on a bird's habitat may be a decrease in prey abundance. Historically winterfat supported the highest densities of Townsend's ground squirrels (Spermophilus townsendii) (Quinney et al. 1987), the principal prey item of nesting ferruginous hawks in the SRBOPA (Kochert and Steenhof 1985). Recent studies conducted in the SRBOPA show that fire decreases small mammal

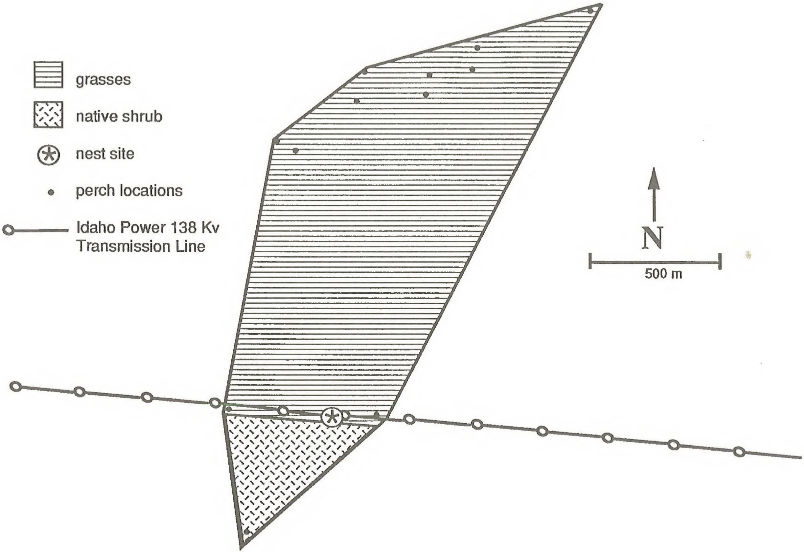

Fig. 5. Habitat composition of use-area for "Big Baha 92" male

Table 6. Percent of grass and rehabilitated burned habitat in home ranges of ferruginous hawks in the SRBOPA.

bird size	%grass	%rehabilitated	total	home range
Powerline	46%	34%	80%	8.71 km^2
PP&L 113/3*	33%	---	40%	25.54 km^2
Big Baha 22	55%	39%	94%	5.71 km^2

* 7% of native shrub burned in June 1988 and is included in total amount of burned habitat

densities and species diversity in this and all other habitat types found in the SRBOPA (Quinney et al. 1987). Prey densities were not determined in this study, nevertheless, results indicate a negative correlation between range size and the amount of burned habitat contained therein. This appears not to be consistent with Newton's findings that range size increases with decreased prey abundance. However, prey may be more available to raptors in areas where fires have removed vegetative cover (Bechard 1982).

Results from one field season are inconclusive, yet they raise interesting questions concerning the home range size and habitat use of ferruginous hawks in habitats with a history of frequent wildfires. Four more male ferruginous hawks will be trapped and radio-tracked in 1989 to obtain additional data on trends in home range size and habitat use related to the occurrence of range fires.

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TITLE: Abundance of Lagomorphs and Rodents in the Snake River Birds of Prey Area.

INVESTIGATORS: John Doremus, Wildlife Biologist, Bruneau Resource Area
Marjorie Blew, Environmental Specialist, Idaho Army National Guard

OBJECTIVE: To monitor changes in the black-tailed jack rabbit (Lepus californicus) population in the Snake River Birds of Prey Area.

COOPERATOR: Idaho Army National Guard

METHODS

We conducted spotlight surveys along 11 previously established transects and 2 new transects (R2D2 and Pleasant Valley). The transects run through major cover types within the study area (Table 1). Both of the new transects are in the Orchard Training Area. The Pleasant Valley transect (13.2 km) runs through big sagebrush (Artemisia tridentata) and big sage/grass vegetation. The R2D2 transect (20.4 km) runs through big sagebrush, grass, winterfat (Ceratoides lanata), shadscale (Atriplex confertifolia) and spiny hopsage (Atriplex spinosa).

Vegetation was recorded along the length of all transects in April or early May prior to the rabbit surveys. Using the same vehicle that was used to survey rabbits, all transects were driven during the daylight hours. The mileage at the start of the transect and at each change in dominant vegetation was recorded to the nearest hundredth of a mile. Each change in vegetation was recorded as either a single dominant (e.g., pure big sage), a co-dominant (e.g., big sage/winterfat), or dominant and sub-dominant (e.g., big sage/grass) vegetation type. These classifications were limited to groups of 2 vegetation species. Vegetation classifications were ocular and based on the observer's subjective assessment of the dominant vegetation.

Each transect was sampled 3 times from 19 May to 2 June, using the method of Smith and Nydegger (1985). A total of 723 km was sampled in 1988. The new OTA transects were selected using the guidelines from the black-tailed jack rabbit spotlight survey instruction memo on file at the Boise District Office. Data were analyzed using the computer program "TRANSECT" (Burnham et al. 1980). The location of all kangaroo rats (Dipodomys ordii, D. microps), Nuttall's cottontails (Sylvilagus nuttalli), pygmy rabbits (Brachylagus idahoensis), voles (Microtus spp.), and mice (Reithrodontomys megalotis, Onychomys leucogaster, Perognathus parvus and Peromyscus maniculatus) seen during the jack rabbit surveys were recorded.

The mileage at each small mammal sighting was recorded to the hundredths of a mile. The location of the mammal sighting was compared with the vegetation mileage to determine the vegetation type where the mammal was seen.

Table 1. Kilometers for the black-tailed jack rabbit transects by habitat type 1988.

Habitat Type		Kilometers
Big sagebrush		122.18
Big sagebrush/Winterfat		50.54
Winterfat		17.92
Shadscale		42.82
Shadscale/Winterfat		33.74
Crested Wheatgrass		46.18
Big sagebrush/Shadscale		27.41
Greasewood		15.36
Greasewood/Shadscale		13.54
Grass		182.98
Rabbitbrush		0.00
Rabbitbrush/Grass		10.56
Big sagebrush/Grass		109.96
Winterfat/Grass		6.86
Shadscale/Grass		21.64
Winterfat/Spiny hopsage		10.80
Big sagebrush/Spiny hopsage		6.00
Spiny hopsage		0.48
Big sagebrush/Crested wheatgrass		1.95
Bare Ground		1.87
	Total	722.79

RESULTS AND DISCUSSION

The number of jack rabbits observed on the 11 baseline transects increased from 85 in 1987 to 175 in 1988. The annual density index, for all cover types, increased from 0.05 jack rabbits/ha in 1987 to 0.39 jack rabbits/ha in 1988 (Table 2). The density of jack rabbits/ha increased from 0.13 to 1.12 in the big sagebrush types from 1987 to 1988 (Table 3).

The number of kangaroo rats seen per unit (N/km) varied from 0.00 to 1.54 depending on cover type (Table 4). Kangaroo rats were found in all cover types except spiny hopsage and rabbitbrush. For all cover types the number of kangaroo rats/km decreased from 1.15/km in 1987 to 0.50/km in 1988. The number of kangaroo rats observed decreased from 703 in 1987 to 362 in 1988 (Table 5).

The total number of Nuttall's cottontails seen decreased from 79 in 1987 to 24 in 1988 (Table 5). The number of Nuttall's cottontails seen per unit effort (N/km) varied from 0 to 0.07 in those cover types where they were found in 1987 (Table 6).

The number of pygmy rabbits seen per unit effort (N/km) decreased from 0.04 in 1987 to 0.01 in 1988 (Table 7) for all cover types. The total number of pygmy rabbits seen decreased from 27 in 1987 to 9 in 1988 (Table 5).

The number of mice seen per unit effort (N/km) varied from 0.04 to 0.09 in those cover types where mice were observed (Table 8). The total number of mice observed decreased from 260 in 1987 to 29 in 1988 (Table 5). No voles were seen in 1988 (Table 5).

Lack of annual vegetation and increased visibility in 1987 was thought to be partially responsible for high numbers of small mammals seen on transects in 1987. However, annual vegetation in 1988 was even more scarce due to prolonged drought conditions, and rodent numbers were considerably lower than in 1987. The decline in small rodent numbers was probably associated with lack of food and cover. 1988 was the second year of well below average rainfall. The structure and density of annual vegetation was greatly reduced. The production of green vegetation and seeds on both annual and perennial vegetation was likewise reduced. Competition for forage between species of small mammals was increased. Livestock also competed with the small mammals by removing both food and cover. It is likely that predation increased as cover decreased.

The information on Nuttall's cottontails and pygmy rabbits could be analyzed on program "TRANSECT" (Burnham et al. 1980), but low numbers of rabbits seen in past years would make comparison of the data very difficult. The information on mice, voles and kangaroo rats was not collected in a manner that allows it to be analyzed on program "TRANSECT" (Burnham et al. 1980).

ACKNOWLEDGMENTS

We thank Karen Steenhof for analyzing the data and writing the report.

Table 2. Annual density estimates of black-tailed jack rabbits from spotlight transects in the Snake River Birds of Prey Area, 1977-1988.

Year	Number of Rabbits Per Km	Density Index[a] (N/ha)	95% Confidence Interval	Coefficient of Variation
1977	0.81	0.16	0.14-0.18	6.86
1978	0.39	0.17	0.14-0.21	10.09
1979	1.25	0.49	0.46-0.53	3.84
1980	1.43	0.48[b]	0.43-0.53	4.98
1981	1.63	0.52	0.49-0.56	3.44
1982	0.52	0.14	0.13-0.16	6.05
1983	0.36	0.13	0.11-0.14	7.36
1984	0.11	0.05	0.04-0.06	13.31
1985	0.10	0.02	0.02-0.03	13.50
1986	0.05	0.03	0.02-0.04	19.06
1987	0.14	0.05	0.04-0.07	11.09
1988	0.29	0.39	0.33-0.45	7.56

[a] Calculated using the Exponential Power Series estimator in program TRANSECT (Burnham et al. 1980).

[b] Calculated using the Negative Exponential estimator.

Table 3. Annual density estimates of black-tailed jack rabbits from spotlight transects in big sagebrush within the Snake River Birds of Prey Area, 1977-1988.

Year	Number of Rabbits Per Km	Density Index[a] (N/ha)	95% Confidence Interval	Coefficient of Variation
1977	1.54	0.23	0.18-0.29	13.01
1978	0.73	0.67	0.48-0.85	14.45
1979	1.88	0.79	0.71-0.86	5.03
1980	2.04	0.75	0.68-0.82	4.76
1981	2.50	0.95	0.86-1.04	4.75
1982	0.90	0.29	0.25-0.34	7.96
1983	0.57	0.29	0.23-0.35	10.26
1984	0.23	0.08	0.06-0.11	17.03
1985	0.17	0.05	0.03-0.06	20.03
1986	0.13	0.05	0.02-0.07	27.01
1987	0.43	0.13	0.09-0.16	14.91
1988	0.86	1.12	0.89-1.36	10.78

[a] Calculated using the Exponential Power Series estimator in program TRANSECT (Burnham et al. 1980).

Table 4. Number of kangaroo rats seen per unit effort (N/km) on the spotlight transects within selected cover types within the Birds of Prey Area, 1988.

Cover type	1988
Big sagebrush	0.24
Big sagebrush/Winterfat	0.20
Big sagebrush/Shadscale	1.13
Big sagebrush/Grass	0.24
Winterfat	0.45
Shadscale	0.70
Shadscale/Winterfat	0.30
Greasewood	1.30
Greasewood/Shadscale	0.66
Grass	0.79
Crested wheatgrass	0.43
Rabbitbrush/Grass	0.57
Winterfat/Grass	0.73
Shadscale/Grass	0.05
Winterfat/Spiny hopsage	0.19
Big sagebrush/Spiny hopsage	1.00
Bare ground	0.53
Big sagebrush/Crested wheatgrass	1.54
Spiny hopsage	0.00
All cover types pooled	0.50

Table 5. Number of small mammals seen on 723 km of spotlight transects, 1988

Species	1988
Nuttall's cottontails	24
Pygmy rabbits	9
Mice	29
Voles	0
Kangaroo rats	362

Table 6. Number of Nuttall's cottontails seen per unit effort (N/km) on the spotlight transects within selected cover types in the Birds of Prey Area, 1988.

Cover type	1988
Big sagebrush	0.07
Big sagebrush/Winterfat	0.06
Shadscale/Winterfat	0.00
Greasewood	0.00
Crested wheatgrass	0.00
Grass	0.01
Big sagebrush/Grass	0.06
Big sagebrush/Shadscale	0.07
Winterfat	0.06
All cover types pooled	0.03

Table 7. Number of pygmy rabbits seen per unit effort (N/km) on the spotlight transects within selected habitat types within the Birds of Prey Area, 1988.

Cover types	1988
Big sagebrush	0.05
Big sagebrush/Winterfat	0.02
Greasewood	0.00
Big sagebrush/Grass	0.02
All cover types pooled	0.01

Table 8. Number of mice seen per unit effort (N/km) on the spotlight transects within selected cover types in the Birds of Prey Area, 1988.

Cover type	1988
Big sagebrush	0.05
Big sagebrush/Winterfat	0.06
Big sagebrush/Shadscale	0.00
Big sagebrush/Grass	0.04
Winterfat	0.00
Shadscale	0.07
Shadscale/Winterfat	0.09
Greasewood	0.00
Greasewood/Shadscale	0.00
Grass	0.04
Crested wheatgrass	0.04
Rabbitbrush/Grass	0.00
All cover types pooled	0.04

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TITLE: Townsend's Ground Squirrel Food Habits and Relative Abundance in the Snake River Birds of Prey Area

INVESTIGATORS: Kristina Timmerman, Wildlife Technician, BLM
Karen Steenhof, Analytical Wildlife Biologist, BLM
Jay Weaver, Biological Technician, Boise State University
Robert Gerber, BLM Volunteer

COOPERATORS: Boise State University
College of Idaho

OBJECTIVES:

1. To continue monitoring the relative abundance of the Townsend's ground squirrel in the Snake River Birds of Prey Area.

2. To investigate the food habits of the Townsend's ground squirrel in burned and unburned, seeded and unseeded big sagebrush/winterfat mosaic habitat in the Snake River Birds of Prey Area.

ANNUAL SUMMARY

Active Townsend's ground squirrel (Spermophilus townsendii or TGS) burrow numbers were lower in 1988 than in all years previously sampled. Badger (Taxidea taxus) burrow numbers were the 3rd lowest in the 4 years sampled. In 1988, winterfat habitat supported the highest mean TGS and badger burrow densities (b/ha) in the Snake River Birds of Prey Area (SRBOPA). Exotic annuals supported the lowest mean TGS and badger densities in 1988. The greatest variation in TGS b/ha among years occurred in exotic annual habitat. Densities were relatively more stable between years in all other habitats sampled. Recent burns had significantly lower TGS densities than old burns and unburned areas. Densities in old burns were higher than in unburned areas, but the difference was not significant in 1988. Range seedings had higher badger densities but lower TGS densities than in 1987. In 1988, 43 TGS stomachs were collected for food habit analysis. Results will be available in spring 1989.

INTRODUCTION

Townsend's ground squirrels are a major food source for raptors, badgers, and other predators. The abundance of prey is a crucial factor contributing to the abundance and diversity of raptors in the Snake River Birds of Prey Area (Nydegger and Smith 1986). Within the SRBOPA the TGS population can vary between years (Smith and Johnson 1985). This variation may be caused by predation, dispersal, weather, and disease, and could affect the populations of raptors and other predators in the area (U.S. Dep. Inter. 1979).

Wildfire is a primary cause of change in species composition and structure within habitats. In the SRBOPA, over 75,000 ha burned and were converted to exotic annuals between 1980 and 1988 (U.S. Dep. Inter. unpublished data). Nydegger and Smith (1986) reported that Big

sagebrush/winterfat (Artemisia tridentata/Ceratoides lanata) and winterfat habitats support higher numbers of TGS than other plant communities in the SRBOPA. Because the TGS population appears to have a high association with specific plant communities, it was considered important to monitor TGS population trends and food habits in altered and relatively unaltered habitat types.

PREVIOUS WORK

In 1982, 190 hole count transects were established to monitor population trends in altered and relatively unaltered habitat types (Johnson et al. 1982). In 1986, Peterson and Yensen (1986) re-sampled 60 of these transects and established a vegetation canopy coverage transect (Daubenmire 1959) on each hole count transect. All 60 transects were permanently marked with fence posts in 1986. In 1987, 54 of the 60 transects were re-sampled. In addition to these 54 transects, 16 transects were established and permanently marked with fence posts in 1986 to monitor the response of small mammals (including TGS) and vegetation to a 1985 wildfire in shadscale (Atriplex confertifolia) and winterfat habitat types (Groves and Steenhof 1988), and 11 transects were established and marked with wooden lathes in 1987 to monitor TGS population and vegetation trends in burned areas that had been reseeded. Peterson and Yensen (1986) concluded that hole count transects seem to be reliable estimators of relative TGS density in the SRBOPA. For a detailed explanation of the methods used in 1982, 1986, and 1987, see Peterson and Yensen (1986). A food habits study was initiated in 1987 and continued in 1988. TGS were collected on 4 sites in the SRBOPA. The vegetation transects on these sites were permanently marked with fence posts.

METHODS

TGS Hole Counts

In 1988, 81 TGS hole count transects were re-sampled. All transects not permanently marked were staked with rebar in 1988, and fence posts were replaced on transects where they were missing. Metal tags with the transect number were attached to fence posts on the 54 transects that have been sampled in 1982, 1986, and 1987.

Of the 81 transects sampled in 1988, 54 were in big sagebrush, winterfat, shadscale, and exotic annual habitat types and were previously censused in 1982, 1986, and 1987. Eleven transects, established in 1987, were located in range seedings. The remaining 16 transects had been established in 1986 in the vicinity of the Black Butte burn and were located in burned, partially burned, burned-reseeded, and native vegetation (shadscale/winterfat).

As in previous years, the belt transect method (Peterson and Yensen 1986) was used on all 81 transects. Each transect was a linear strip 44-m long and 5-m wide (2000 m^2). A flexible pole with lightweight chains approximately 1-m long at each end was used to define the transect width of 5-m. One observer held the pole at its center and walked the center line of the transect. The observer counted all active and inactive TGS and badger burrows. Active holes were determined by the censusers as those used by

ground squirrels or badgers during the year of the census, as evidenced by tracks, claw marks, and feces, and by sightings of the animals in the burrow entrances. A second observer walked systematically back and forth within the 5-m belt searching for active and inactive TGS and badger burrows. The 2 observers were in constant communication with each other to prevent duplication of the burrow count.

On all 81 transects, abundance of TGS was determined by counts of active TGS holes. Inactive holes were also recorded. All TGS and badger burrows were converted to burrows per ha so that comparisons with 1982, 1986, and 1987 data could be made.

On all transects, vegetation canopy cover was recorded following the method of Daubenmire (1959). Forty 1-m^2 plots were sampled along each hole count transect. Plots were located at 10-m intervals and were sampled from 1-40 consecutively. A sampling square (74.9 cm x 133.3 cm) made of rebar defined the area of each plot. Percent canopy cover of each species present was estimated and recorded.

TGS Food Habits

Townsend's ground squirrels were collected on 4 sites. These were the same sites sampled in 1987. Sites 1 and 2 were burned in 1983. Site 3, the control site, was a big sagebrush/winterfat community 1.6 km south of sites 1 and 2. Site 4 was burned in 1981 and had been seeded in the same year with winterfat, crested wheatgrass and other species.

TGS were collected with .22 caliber and 6 mm varmint rifles. The sampling technician drove slowly (5-12 km) along access roads on the collection sites until TGS were in shooting range. Shooting range was 68 m for the .22 caliber rifle and 274 m for the 6 mm varmint rifle. Eight to ten hours was spent at each collection site.

Each squirrel collected was aged, sexed, weighed, labeled, and its stomach removed. Each stomach was labeled and placed in a vial of 70% ethanol. Carcasses were donated to the College of Idaho Museum of Natural History. Stomach analysis will follow Sparks and Malachek (1968). Reproductive tracts are stored at the College of Idaho. A placental count will be done by E. Yensen.

On all sites, vegetation canopy cover was recorded following the method of Daubenmire (1959). Forty 1-m^2 plots were sampled along each hole count transect. Plots were located at 10-m intervals and were sampled from 1-40 consecutively. A sampling square (74.9 cm x 133.3 cm) made of rebar defined the area of each plot. Percent canopy cover of each species present was estimated and recorded.

RESULTS

TGS Hole Counts

In 1988, the number of active TGS burrows was lower than in all previous years when surveys were conducted. The total number of burrows counted on 54 transects was 3655 (67.7 b/ha), a decrease of 54.9% from the 1987 average, 150.1 b/ha (Table 1). This decline was statistically significantly different (Wilcoxon signed ranks test $\underline{T} = -189.5$, $\underline{n} = 54$, $\underline{P} = < 0.001$).

Precipitation at the Kuna Weather Station between November and April was 22 cm (1981/1982), 25 cm (1985/1986), 9 cm (1986/1987), and 15 cm (1987/1988). Mean TGS densities showed no correlation with winter rainfall preceding the sampling year (Spearman rank correlation, $r_s = 0.6$, $\underline{n} = 4$, $\underline{P} > 0.10$), but densities were associated with winter rainfall 1 year prior to the sampling year (Spearman rank correlation, $r_s = 0.8$, $\underline{n} = 4$, $0.10 < \underline{P} < 0.05$).

In 1988, active TGS burrow numbers remained the same as in 1987 on 6 transects. Of these 6, 4 had no active burrows in either 1987 or 1988. Between 1987 and 1988, active burrow entrances increased on 7 transects and decreased on 41 transects. In 1987, the number of active TGS burrows increased on 72% of the transects. In 1988, the number of active TGS burrows decreased on 75% of the transects. Of transects with decreases in 1988, 12 were in winterfat, 4 were in big sagebrush, 3 were in shadscale, and 22 were in exotic annuals. Of transects with increases, 3 were in winterfat, 2 were in big sagebrush, none were in shadscale, and 2 were in exotic annuals (Table 1). One of the transects (#5) typed as exotic annual in 1988 was typed as winterfat in 1982, 1986, and 1987. This transect burned in late 1987.

The badger population index increased from 3.1 b/ha in 1987 to 8.8 b/ha in 1988, which was not a statistically significant difference (Wilcoxon signed ranks test $\underline{T} = 524$, $\underline{n} = 54$, $0.05 < \underline{P} < 0.10$). The 1988 average badger density was 87% lower than the 1982 density of 66.9 b/ha (Table 2). As in past years, there was a high positive correlation (Spearman rank correlation $r_s = 0.0624$, $\underline{n} = 54$, $\underline{P} < 0.001$) between the number of active TGS burrows and active badger burrows on transects in 1988.

Among the 54 transects sampled in 1988, the winterfat vegetation type supported the highest mean number of TGS b/ha in 1988, but was well below the 290 b/ha recorded in 1982 and 1987 (Table 3). The 1988 TGS burrow density in winterfat was 175.3 b/ha, 39% below 1987 levels. In sagebrush, 7 transects had an average burrow density of 56.4 b/ha in 1988. This was a 14% decline from the 1987 densities (65.7 b/ha). In 1988, the 4 shadscale transects had an average density of 23.8 b/ha, a 47% decline from the 1987 level (45.0 b/ha). Exotic annuals had the lowest TGS density among the 4 vegetation types in 1988, 19.1 b/ha. This was an 82% decline from the 1987 density of 104.6 b/ha (Table 3).

In 1988, 6 transects in stands that have been dominated by exotic annuals throughout the study period (1982 - 1988) had higher average TGS densities (30.0 b/ha) than 22 stands that had been converted to exotic annuals since 1982 (16.1 b/ha), but the differences were not statistically significant (Mann-Whitney $\underline{U} = 49.5$; $\underline{P} = 0.34$). TGS densities on these 6 transects have

Table 1. Townsend's ground squirrel burrows/hectare on the same transects in 1982, 1986, 1987, and 1988 in the Snake River Birds of Prey Area, Ada and Elmore Counties, Idaho (1982 and 1986 data from Petersen and Yensen 1986). Vegetation acronyms are as follows : CELA = winterfat, ARTR = big sagebrush, ATCO = shadscale, EXAN = exotic annuals (cheatgrass, mustards, Sandberg's bluegrass.

#	Transect #	Vegetation Type 1982	1986	1987	1988	Burrows/h 1982	1986	1987	1988
1	4	CELA	CELA	CELA	CELA	735	315	505	455
2	5	CELA	CELA	CELA	EXAN	131	230	320	55
3	6	CELA	CELA	CELA	CELA	232	180	240	80
4	7	CELA	CELA	CELA	CELA	373	260	645	225
5	13	CELA	CELA	CELA	CELA	624	370	120	275
6	14	CELA	CELA	CELA	CELA	342	100	250	315
7	15	CELA	CELA	CELA	CELA	453	150	625	295
8	16	CELA	CELA	CELA	CELA	322	340	470	255
9	17	CELA	CELA	CELA	CELA	201	130	95	50
10	18	CELA	CELA	CELA	CELA	322	340	230	120
11	20	CELA	CELA	CELA	CELA	60	55	55	80
12	21	CELA	CELA	CELA	CELA	60	25	105	95
13	22	ARTR	ARTR	ARTR	ARTR	483	35	70	50
14	23	ARTR	ARTR	ARTR	ARTR	70	40	95	85
15	24	ARTR	ARTR	ARTR	ARTR	131	35	55	65
16	26	EXAN	EXAN	EXAN	EXAN	584	5	170	80
17	33	ARTR	EXAN	EXAN	EXAN	101	70	155	60
18	34	ARTR	ARTR	ARTR	ARTR	242	30	55	35
19	35	ARTR	EXAN	EXAN	EXAN	322	120	195	25
20	50	ARTR	EXAN	EXAN	EXAN	393	105	115	60
21	51	ARTR	EXAN	EXAN	EXAN	111	45	30	50
22	53	ARTR	ARTR	ARTR	ARTR	121	15	15	20
23	54	EXAN	EXAN	EXAN	EXAN	201	15	30	0
24	55	ARTR	EXAN	EXAN	EXAN	262	20	145	5
25	56	CELA	CELA	CELA	CELA	363	270	560	170
26	57	CELA	CELA	CELA	CELA	201	180	330	170
27	121	ARTR	ARTR	ARTR	ARTR	121	170	110	80
28	122	ATCO	EXAN	EXAN	EXAN	0	0	0	0
29	123	ATCO	EXAN	EXAN	EXAN	20	0	0	0
30	124	ATCO	EXAN	EXAN	EXAN	20	25	15	0
31	125	ATCO	EXAN	EXAN	EXAN	0	0	10	0
32	126	ATCO	EXAN	EXAN	EXAN	0	0	5	0
33	127	ATCO	EXAN	EXAN	EXAN	252	0	15	0
34	128	ATCO	EXAN	EXAN	EXAN	50	0	15	30
35	147	ATCO	EXAN	EXAN	EXAN	101	5	30	15
36	148	ATCO	EXAN	EXAN	EXAN	50	5	10	5
37	149	ATCO	ATCO	ATCO	ATCO	111	0	5	0
38	150	ATCO	EXAN	EXAN	EXAN	10	5	0	0
39	151	ATCO	EXAN	EXAN	EXAN	0	0	0	0
40	152	ATCO	EXAN	EXAN	EXAN	30	0	10	0
41	161	ATCO	EXAN	EXAN	EXAN	10	0	20	15
42	162	ATCO	EXAN	EXAN	EXAN	232	30	30	20
43	165	ARTR	ARTR	ARTR	ARTR	30	60	60	60
44	172	ATCO	ATCO	ATCO	ATCO	141	90	115	65
45	182	ATCO	EXAN	EXAN	EXAN	50	30	5	10
46	183	ATCO	EXAN	EXAN	EXAN	40	0	65	5
47	200	EXAN	EXAN	EXAN	EXAN	222	25	100	20
48	201	EXAN	EXAN	EXAN	EXAN	332	20	830	0
49	202	EXAN	EXAN	EXAN	EXAN	796	75	725	15
50	203	EXAN	EXAN	EXAN	EXAN	70	65	100	65
51	204	ATCO	ATCO	ATCO	ATCO	50	20	30	30
52	205	CELA	CELA	CELA	CELA	141	10	35	20
53	206	CELA	CELA	CELA	CELA	81	15	55	25
54	207	ATCO	ATCO	ATCO	ATCO	60	0	30	0
Total burrow entrances						10460	4130	8105	3655
$\bar{X}$ burrows/h						193.3	76.5	150.1	67.7

Table 2. Number of badger burrows in different vegetation types in the Snake River Birds of Prey Area in 1982, 1986, 1987, and 1988. Number of transects in parentheses.

Vegetation Type	Burrows/ha (# transects)			
	1982	1986	1987	1988
Ceratoides lanata	119.0(16)	53.2(16)	6.9(16)	19.7(15)
Artemisia tridentata	62.8(12)	8.6(7)	2.1(7)	12.1(7)
Atriplex confertifolia	9.5(20)	11.3(4)	2.5(4)	5.0(4)
Exotic Annuals	127.7(6)	5.7(27)	1.3(27)	2.7(28)
Total # burrows	3614(54)	1110(54)	170(54)	475(54)
$\bar{x}$ Badger b/ha	66.9	20.9	3.1	8.8

Table 3. Mean number of active Townsend's ground squirrel burrows per hectare in the Snake River Birds of Prey Area in 1982, 1986, 1987, and 1988. Number of transects in parentheses.

Vegetation Type	Burrows/ha (# transects)			
	1982	1986	1987	1988
Ceratoides lanata	290.1(16)	185.6(16)	290.0(16)	175.3(15)
Artemisia tridentata	198.9(12)	55.0 (7)	65.7 (7)	56.4 (7)
Atriplex confertifolia	61.4(20)	27.5 (4)	45.0 (4)	23.8 (4)
Exotic Annuals	367.5 (6)	24.6(27)	104.6(27)	19.1(28)
$\bar{x}$ TGS b/ha	193.3(54)	76.5(54)	150.1(54)	67.7(54)

been extremely volatile during the study, varying from 367.7 b/ha and 325.8 b/ha in 1982 and 1987, respectively to 34.2 b/ha and 30.0 b/ha in 1986 and 1988 respectively (Figure 1). The year to year variability of these 6 transects has been much higher (c.v. = 96%) than the variation on 26 transects that have been dominated by native vegetation throughout the study period (c.v. = 28%, 65%, and 43% for winterfat, sagebrush, and shadscale, respectively). In 1982 and 1987 average TGS densities on the 6 exotic annual transects were higher than on all 3 native vegetation types, but in 1986 and 1988, they were lower than all types except shadscale.

TGS densities differed significantly among transects that had never burned, had burned more than 7 years before, and had burned within the previous 7 years (Table 4, $\underline{F} = 7.5$; $\underline{P} = 0.001$). In all 3 years, transects on recent burns had significantly lower TGS densities than transects on old burns and unburned areas (Duncan's New Multiple Range Test, $\underline{P} < 0.05$). Densities on old burns were higher than on unburned areas in each of the 3 years, but differences were significant only in 1987.

Only 1 of 22 transects that burned for the first time between 1982 and 1988 had higher TGS densities in 1988 than in 1982. Wilcoxon Matched-Pair Signed Ranks Tests suggested a significant decline ($\underline{Z} = -3.68$, $\underline{P} = 0.0002$) in densities on these recently burned transects. Declines were also significant in 1986 for transects burned for the first time between 1982 and 1986 ($\underline{Z} = -3.55$, $\underline{P} = 0.0004$) and in 1987 for transects that burned for the first time between 1982 and 1987 ($\underline{Z} = -2.64$, $\underline{P} = 0.008$) even though 5 of 21 transects showed increases in 1987.

Three years after the Black Butte burn, TGS densities were still higher on the control transects than within the burn (Table 5). As in 1986, transects in partial burns had the second highest densities. Densities on the burned/reseeded transects were unchanged, but numbers of holes on the burned areas with no treatment dropped from 11.3 b/ha 1 year after the burn to 0 in 1988. The 16 Black Butte burn transects supported an average TGS density of 17.2 b/ha in 1988, slightly lower than the 1986 density of 20.0 b/ha (Table 5). In 1988, the 4 control transects (native vegetation) had 50.0 b/ha, the 4 partial burn transects had 10.0 b/ha, the 4 burn/reseeded transects had 8.8 b/ha, and the 4 burn/no treatment transects had 0.0 b/ha.

In 1988, the 11 range seeding transects supported an average of 57.3 TGS b/ha, 15.4% lower than the 1987 average density of 67.7 b/ha (Table 6). None of the range seedings were dominated by seeded species. Badger densities in range seedings increased from 3.1 b/ha to 17.7 b/ha in 1988. Discrepancies were found concerning the age of seedings. All but one of the seeding ages listed in Table 6 do not agree with seeding ages or boundaries found on fire or seeding maps in the SRBOPA or fire office.

The 11 range seedings sampled in 1988 were co-dominated by Sandberg's bluegrass (<u>Poa sandbergii</u>), Russian thistle (<u>Salsola kali</u>), and/or cheatgrass (<u>Bromus tectorum</u>, Table 7). In contrast, exotic annuals (primarily cheatgrass) dominated all 11 transects in 1987 (Table 7).

Mean canopy cover provided by winterfat in winterfat habitat was 7.2% in 1988 (Table 8). Sandberg's bluegrass provided 2.5% mean canopy cover. In all years that transects in winterfat were sampled (1986, 1987, and 1988),

Table 4. Mean number of active Townsend's ground squirrel burrows on transects that have not burned, had burned more than 7 years before, and had burned within the previous 7 years in 1982, 1986, and 1988. Number of transects in parentheses.

Burn Condition	Burrows/ha 1986	1987	1988
Burned ≤ 7 years	20.7 (23)	40.9 (22)	14.8 (25)
Burned > 7 years	130.6 (9)	369.5 (10)	154.2 (6)
Unburned	112.7 (22)	159.5 (22)	102.6 (23)

Table 5. Numbers of active Townsend's ground squirrel burrows per hectare and minimum/maximum hole counts per transect on the Black Butte burn transects in 1986 and 1988 (4 transects per range condition).

Range Condition	1986 min/max b/ha	1986 $\bar{x}$ b/ha	1988 min/max b/ha	1988 $\bar{x}$ b/ha
Control	20/60	36.3	20/85	50.0
Partial Burn	5/40	23.8	0/35	10.0
Burn/Reseeded	5/20	8.8	0/25	8.8
Burn/No Treatment	0/35	11.3	0/0	0.0
Total $\bar{x}$ b/ha		20.0		17.2

Table 6. Townsend's ground squirrel and badger burrow densities in range seedings in 1987 and 1988 (11 transects).

Transect Number	Seeding Year	2 Plant Species[1] (Dominant)		Vegetation Type	TGS burrows/ha		Badger burrows/ha	
		1987	1988		1987	1988	1987	1988
G1	1986[2]	BRTE POSA	SAKA POSA	Exotic Annuals	60	125	5	20
G2	1986[2]	BRTE SIHY	POSA SAKA	Exotic Annuals	15	100	0	85
G3	1983[2]	BRTE POSA	POSA SAKA	Exotic Annuals	85	90	0	20
G4	1983[2]	BRTE POSA	SAKA POSA	Exotic Annuals	175	60	0	10
G5	1986[2]	BRTE POSA	POSA SAKA	Exotic Annuals	65	15	0	10
G6	1986[2]	BRTE POSA	POSA SIHY	Exotic Annuals	85	35	15	15
1001	1985[2]	BRTE DEPI	BRTE ARTR	Exotic Annuals	55	15	5	0
1002	1985[2]	BRTE SIHY	BRTE SAKA	Exotic Annuals	15	0	0	0
1003	1985[2]	BRTE DEPI	SAKA BRTE	Exotic Annuals	0	0	0	0
1005	1985[2]	BRTE DEPI	BRTE CELA	Exotic Annuals	10	15	0	5
1010	1981[2]	BRTE POSA	POSA ATNU	Exotic Annuals	180	175	0	30
$\bar{x}$ b/ha					67.7	57.3	3.1	17.7

1. Vegetation acronyms are as follows:
BRTE = Bromus tectorum, POSA = Poa sandbergii, SIHY = Sitanion hystrix, SAKA = Salsola kali, DEPI = Descurainia pinnata, ARTR = Atriplex tridentata, ATNU = Atriplex nutalli, CELA = Ceratoides lanata.

2. Discrepency in seeding year or mapped location

Table 7. Mean percent canopy cover for plant species on TGS hole count transects in range seedings in 1987 and 1988 (11 transects).

Species	Mean % Canopy Cover 1987	1988
Artemisia tridentata	----	0.2
Artemisia spinosa	----	trace
Ceratoides lanata	0.2	trace
Atriplex confertifolia	----	trace
Atriplex spinosa	----	trace
Atriplex nutalli	----	0.2
Chrysothamnus spp.	----	trace
Tetradymia glabrata	----	trace
Bromus tectorum	13.2	3.9
Salsola kali	0.1	4.6
Poa sandbergii	0.7	4.7
Sitanion hystrix	0.4	1.0
Vulpia octoflora	trace	0.2
Lepidium perfoliatum	----	trace
Oryzopsis hymenoides	----	trace
Lactuca serriola	----	trace
Halogeton glomeratus	----	0.2
Agropyron cristatum	0.1	0.4
Sisymbrium altissimum	0.2	0.3
Descurainia pinnata	trace	trace
Other forbs	----	0.1
Other grasses	----	0.1
$\bar{x}$ % canopy cover	14.9	15.9

Note: trace denotes that plant species was present in concentrations of $\leq$ 0.009%.

Table 8. Mean % canopy cover for plant species on TGS hole count transects in winterfat vegetation in 1986, 1987, and 1988 (16 transects used in 1986 and 1987, 15 transects used in 1988).

Species	Mean % Canopy Cover 1986	1987	1988
Artemisia tridentata	1.3	1.0	0.5
Artemisia spinosa	----	----	0.2
Ceratoides lanata	31.9	7.2	7.2
Atriplex confertifolia	0.6	0.1	0.3
Atriplex spinosa	1.6	0.4	0.1
Chrysothamnus spp.	----	----	trace
Lactuca serriola	----	----	trace
Poa sandbergii	8.0	2.4	2.5
Sitanion hystrix	2.0	0.4	0.5
Vulpia octoflora	3.8	0.1	0.1
Bromus tectorum	7.1	1.1	0.8
Sisymbrium altissimum	1.9	trace	----
Descurainia pinnata	6.5	0.2	trace
Salsola kali	----	----	0.2
Halogeton glomeratus	----	----	0.01
Crepis spp.	trace	----	----
Ranunculus testiculatus	0.9	----	----
Cryptantha spp.	1.2	----	----
Oryzopsis hymenoides	0.1	----	trace
Unknown	0.7	----	----
Other forbs	----	----	0.1
Other grasses	----	----	trace
$\bar{x}$ percent canopy cover	67.6	12.9	12.5

Note: trace indicates that species was present in percentages of $\leq$ 0.009.

winterfat provided the highest amount of canopy cover and Sandberg's bluegrass, the second highest amount of canopy cover. When comparing canopy cover of winterfat in 1986 and 1988, a decline in cover of 77% is observed (Table 8). Despite this decline, winterfat had a higher percentage of the mean total canopy cover in 1988 than in 1986 (57.6% and 47.2% respectively).

In 1988, the principal plant species on 7 transects in big sage habitat were big sage, 8.8%, cheatgrass, 3.8%, and Sandberg's bluegrass, 2.8% (Table 9). In 1988, big sagebrush provided 48.4% of the mean total cover. Cheatgrass provided 21.0%, and Sandberg's bluegrass provided 15.4% of the mean total cover. All other species combined provided less than 6.0% of the mean total canopy cover.

Mean canopy cover provided by shadscale in shadscale habitat was 2.0% in 1988 (Table 10). Cheatgrass and squirreltail (Sitanion hystrix) had 1.8% and 1.3% mean canopy cover respectively (Table 10). In 1988, shadscale comprised 27.8% of the total mean canopy cover on 4 transects. Cheatgrass provided 25.0% and squirreltail provided 18.1% of the total mean canopy cover.

In 1988, mean canopy cover of cheatgrass in exotic annual habitat was 5.3% (Table 11). Other dominant species were Russian thistle, 2.3% cover and Sandberg's bluegrass, 1.6% cover (Table 11). All other species combined provided 2.8% mean cover. Relative to the mean total canopy cover (12.0%), cheatgrass provided 44.2%. Russian thistle provided 19.2% and Sandberg's bluegrass provided 13.3% of the mean total canopy cover.

TGS Food Habits

Between 1 March and 19 May 1988, 43 squirrels were collected on the 4 sites (Table 12). In 1987, squirrels were collected between 28 May and 19 June. In 1988, 90% of all animals collected were adults or subadults, in contrast to 100% juveniles (young of year) collected in 1987. In 1988, 5 TGS were collected on site 1, 9 on site 2, 12 on site 3, and 16 on site 4 (Table 12). All stomachs have been delivered to E. Yensen of the Department of Biology, College of Idaho, Caldwell. These are currently being analyzed, and results will be available in summer 1989.

In 1987 and 1988, site 1 was dominated by the native perennial Sandberg's bluegrass (Table 13). Site 2 was dominated by Sandberg's bluegrass in 1987. In 1988, it was dominated by bottlebrush squirreltail and Sandberg's bluegrass (Table 13). Site 3, the control, was dominated by big sagebrush, winterfat, and Sandberg's bluegrass in 1987 and 1988. Site 4 was dominated by Sandberg's bluegrass and Russian thistle in 1987. In 1988, it was dominated by Sandberg's bluegrass and bottlebrush squirreltail.

Errors were found when the 1987 food habit results were reviewed. Stomach samples are still on file at the College of Idaho, Caldwell. E. Yensen will re-analyze the samples. Results will be available in summer 1989.

Table 9. Mean % canopy cover for plant species on TGS hole count transects in big sagebrush vegetation 1986, 1987, and 1988 (7 transects).

Species	Mean % Canopy Cover		
	1986	1987	1988
Artemisia tridentata	25.9	9.1	8.8
Ceratoides lanata	trace	0.2	----
Atriplex spinosa	----	----	0.2
Chrysothamnus spp	0.3	0.1	0.1
Atriplex nutallii	----	----	0.1
Poa sandbergii	7.7	4.2	2.8
Sitanion hystrix	2.4	0.4	0.9
Vulpia octoflora	3.3	0.5	0.8
Bromus tectorum	18.8	2.3	3.8
Sisymbrium altissimum	1.1	----	0.2
Descurainia pinnata	1.2	----	trace
Lepidium perfoliatum	0.5	----	trace
Salsola kali	----	----	0.3
Lactuca serriola	0.1	----	trace
Ranunculus testiculatus	0.3	----	----
Elymus cinereus	0.2	----	----
Crepis spp.	trace	----	----
Allium spp.	trace	----	----
Cryptantha spp.	trace	----	----
Other forbs	----	----	0.2
Other grasses	----	----	trace
$\bar{x}$ % canopy cover	61.8	16.8	18.2

Table 10. Mean % canopy cover for plant species on TGS hole count transects in shadscale vegetation in 1986, 1987, and 1988 (4 transects).

Species	Mean % Canopy Cover 1986	1987	1988
<u>Artemisia tridentata</u>	0.1	0.4	----
<u>Artemisia spinosa</u>	----	----	1.0
<u>Ceratoides lanata</u>	2.4	0.2	0.5
<u>Atriplex confertifolia</u>	10.1	2.3	2.0
<u>Atriplex spinosa</u>	0.7	0.1	----
<u>Atriplex nutallii</u>	----	trace	----
<u>Poa sandbergii</u>	0.8	0.8	0.6
<u>Sitanion hystrix</u>	6.9	0.7	1.3
<u>Vulpia octoflora</u>	0.6	trace	trace
<u>Bromus tectorum</u>	23.8	0.6	1.8
<u>Sisymbrium altissimum</u>	5.2	----	----
<u>Descurainia pinnata</u>	1.1	0.1	----
<u>Halogeton glomeratus</u>	----	trace	----
<u>Oryzopsis hymenoides</u>	trace	----	trace
<u>Cryptantha</u> spp.	trace	----	----
<u>Tetradymia glabrata</u>	0.2	----	----
Unknown plant species	0.6	----	----
$\bar{x}$ % canopy cover	52.5	5.2	7.2

Table 11. Mean % canopy cover for plant species on TGS hole count transects in exotic annual vegetation in 1986, 1987, and 1988 (27 transects in 1986 & 1987, 28 transects in 1988).

Species	Mean % Canopy Cover 1986	1987	1988
Artemisia tridentata	0.5	0.1	0.1
Artemisia spinosa	----	----	0.1
Ceratoides lanata	0.1	0.1	0.1
Atriplex confertifolia	0.4	----	0.2
Atriplex spinosa	trace	trace	trace
Chrysothamnus spp.	----	trace	trace
Atriplex nutallii	----	trace	0.2
Poa sandbergii	4.8	1.2	1.6
Sitanion hystrix	1.4	trace	0.5
Vulpia octoflora	0.2	trace	0.1
Agropyron cristatum	1.9	0.3	0.4
Bromus tectorum	39.6	5.0	5.3
Sisymbrium altissimum	11.3	1.1	0.4
Descurainia pinnata	6.3	trace	0.1
Lepidium perfoliatum	2.1	0.2	0.2
Salsola kali	0.2	0.2	2.3
Halogeton glomeratus	----	trace	0.3
Lactuca serriola	0.2	----	trace
Cryptantha spp.	0.3	----	----
Ranunculus testiculatus	trace	----	----
Oryzopsis hymenoides	trace	----	----
Crespis acuminata	trace	----	----
Erodium cicutarium	trace	----	----
Unknown	1.0	----	----
Other forbs	----	----	0.1
$\bar{x}$ % canopy cover	70.3	8.2	12.0

Note: trace indicates that species was present in percentages of $\leq$ 0.009.

Table 12. Townsend's Ground Squirrels collected for a food habits study on the Snake River Birds of Prey in 1988. Note: unk=unknown.

Identification Number	Date Collected	Age	Sex	Site
1	no date, still in D.Q.'s possession			
2	05 Mar 88	unk	unk	1
3	05 Mar 88	adult	female	1
4	17 Mar 88	adult	female	1
5	17 Mar 88	adult	male	2
6	17 Mar 88	adult	male	3
7	17 Mar 88	adult	female	3
8	17 Mar 88	adult	male	2
9	17 Mar 88	subadult	male	1
10	17 Mar 88	adult	female	3
11	17 Mar 88	adult	female	2
12	17 Mar 88	adult	female	2
13	17 Mar 88	adult	male	3
14	17 Mar 88	adult	male	3
15	20 Mar 88	adult	male	3
16	20 Mar 88	adult	female	3
17	20 Mar 80	adult	male	2
18	20 Mar 88	adult	male	4
19	20 Mar 88	adult	male	4
20	20 Mar 88	adult	male	4
21	20 Mar 88	adult	female	4
22	20 Mar 88	adult	female	4
23	unk	adult	female	4
23A	20 Mar 88	adult	male	4
23B	20 Mar 88	adult	female	4
25	20 Mar 88	adult	male	4
26	26 Mar 88	adult	female	4
27	26 Mar 88	adult	male	4
28	26 Mar 88	adult	female	4
30	26 Mar 88	adult	female	4
31	26 Mar 88	adult	male	4
32	26 Mar 88	adult	female	4
33	26 Mar 88	adult	female	4
1-1	16 May 88	subadult	female	3
1-2	16 May 88	adult	female	1
1-3	18 May 88	adult	male	2
1-4	18 May 88	adult	female	3
1-5	19 May 88	adult	male	3
1-6	19 May 88	adult	male	2
1-7	19 May 88	adult	male	2
1-8	19 May 88	adult	female	2
1-9	19 May 88	adult	male	2
1-10	19 May 88	subadult	female	3

Table 13. Mean percent canopy coverage on 4 Townsend's Ground Squirrel collection sites in the Snake River Birds of Prey Area in 1987 and 1988.

Species	Site 1 1983 Burn		Site 2 1983 Burn		Site 3 Control		Site 4 1981 Burn	
	1987	1988	1987	1988	1987	1988	1987	1988
Artemisia tridentata	0.03	---	0.30	0.08	3.15	8.83	---	---
Ceratoides lanata	0.08	0.25	0.43	---	5.03	7.23	---	---
Poa sandbergii	4.35	5.55	5.43	3.63	5.45	6.18	4.50	5.35
Sitanion hystrix	0.03	1.20	0.10	2.90	0.18	0.70	1.03	3.55
Vulpia octoflora	1.48	---	1.53	0.33	0.23	0.15	0.43	0.05
Bromus tectorum	---	3.25	---	1.55	---	0.03	---	2.93
Sisymbrium altissimum	0.98	1.73	---	0.75	---	0.23	---	0.08
Descurainia pinnata	---	---	---	---	---	---	.05	---
Salsola kali	3.60	0.83	4.45	0.05	---	---	3.23	0.43
Atriplex nutallii	---	---	---	---	---	---	---	1.45
Agropyron cristatum	---	---	---	---	---	---	1.15	0.03
Lactuca serriola	---	---	---	---	---	---	0.03	---
Other forbs	---	0.70	---	0.05	---	0.08	---	0.00

DISCUSSION

Vegetation communities consisting of perennials, annuals, and forbs should support a more stable population over time because green vegetation is available for a longer time period (Nydegger and Smith 1986). Winterfat supported more TGS b/ha than either big sagebrush or shadscale in all years sampled. Winterfat supported more TGS b/ha than exotic annuals in all years sampled except 1982. The high palatability of winterfat (Peterson and Yensen 1986) and its associated native grasses (Stevens et al. 1977) may be partly responsible for the higher densities of TGS in these communities.

In the SRBOPA, Smith and Johnson (1985) reported that the TGS diet consisted of green plant material, particularly grasses. Important species were Sandberg's bluegrass and cheatgrass. Studies in western Nevada, eastern Washington, and western Utah found that TGS eat primarily green herbaceous vegetation (Alcorn 1940, Scheffer 1941, Rickart 1982). Rickart also found that seeds of grasses and forbs became an increasingly important part of the TGS diet as the season progressed in western Utah.

Big sagebrush and shadscale stands in the SRBOPA had a lower TGS density than winterfat stands in all years (Table 3). Higher TGS densities may occur in winterfat because a higher percentage of the total mean canopy cover is available as a food item on the winterfat transects. On the sagebrush and shadscale transects, edible plant species (squirreltail, cheatgrass, winterfat, Sandberg's bluegrass, and six-week fescue (E. Yensen pers. commun.) provide 46% and 58% respectively, of the mean canopy cover. Edible plant species on exotic annual transects provided 63% of the mean total canopy cover. In 1988, edible plant species provided 89% of the mean total canopy cover on winterfat transects.

Since 1982, the TGS population, as measured by hole counts, decreased between 1982 and 1986, increased in 1987, and decreased again in 1988. Peterson and Yensen (1986) suggested that the 1982-1986 TGS decline may have been partly the result of short-term weather changes and/or fluctuating food availability. Smith and Johnson (1985) found that in years of low food availability, squirrel reproduction was suspended.

Annual precipitation on the SRBOPA is 20 cm (U.S. Dep. Inter, 1979). Most precipitation falls between November and April. Precipitation during this time period is critical for the growth of annual and perennial grasses, important food items for TGS (Rickart 1987, E. Yensen 1989, pers. commun.) Litter size has been positively correlated to winter rainfall in the round-tailed ground squirrel (<u>Spermophilus</u> <u>tereticaudus</u>; Reynolds and Turkowski 1972), but in the SRBOPA, no relationship was found between TGS densities and winter rainfall in the preceding year. There may, however, be a 1-year lag effect because densities were correlated with winter rainfall the year prior to the hole count sampling.

Since 1982, 28 of the original 60 hole count transects have been converted from native vegetation to exotic annuals. The effects of fire and changing vegetation stands in TGS habitat are still unclear. In 1988, exotic annuals supported the lowest TGS density (19.1 b/ha) as compared to winterfat, big sagebrush, and shadscale. Recent burns (< 7 years old) had

the lowest TGS densities in all years sampled, but TGS densities on old burns (> 7 years old) were higher than on unburned areas.

Fires probably have little direct effect on TGS, because squirrels have usually estivated prior to the fire season. Squirrel populations may, however, be affected indirectly by fires. In southern Idaho, desert fires kill shrubs and native forbs, which are then replaced by exotic annuals (Yensen 1980). Habitats dominated by exotic annuals may provide less cover, possibly increasing the vulnerability of squirrels to predation; and may have less soil moisture and shorter growing seasons than shrub habitats (Peterson and Yensen 1986, Nydegger and Smith 1986). Factors that make old burns more suitable for ground squirrels are still not understood.

Sandberg's bluegrass, bottlebrush squirreltail, and cheatgrass are at least partially resistance to fire (Bunting 1985, Wright 1985). The productivity of Sandberg's bluegrass and bottlebrush squirreltail can be higher during the first few years after a fire. Repeated burning can promote cheatgrass growth and deplete perennials (Wright 1985).

On the 11 range seedings, mean canopy cover was at similar levels in 1987 and 1988, but the percentage contributed by cheatgrass fluctuated each year. In 1987, cheatgrass comprised 82.3% of the mean total cover. In 1988, cheatgrass comprised 23.4% of the mean total cover. Cheatgrass may out-compete other species because it germinates earlier in the growing season (Smith and Johnson 1985).

PLANS FOR NEST YEAR

Additional analyses of trends and habitat relationships will continue. Habitat categories will be re-evaluated based on a cluster analysis of vegetation data. Hole counts will continue in 1989, if funds are available.

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Appendix 1. Number of active and inactive TGS burrows on 54 transects in the Snake River Birds of Prey Area, 1982-1988. Inactive burrows were not counted in 1982.

Transect #	Active Burrows/ha				Inactive Burrows/ha			
	1982	1986	1987	1988	1982	1986	1987	1988
4	735	315	505	455	--	40	120	260
5	131	230	320	55	--	50	30	185
6	232	180	240	80	--	55	100	135
7	373	260	645	225	--	85	300	200
13	624	370	120	275	--	120	30	470
14	342	100	250	315	--	40	30	130
15	453	150	625	295	--	75	120	105
16	322	340	470	255	--	135	145	165
17	201	130	95	50	--	90	60	140
18	322	340	230	120	--	135	130	125
20	60	55	55	80	--	50	35	130
21	60	25	105	95	--	35	40	150
22	483	35	70	50	--	--	70	30
23	70	40	95	85	--	25	35	65
24	131	35	55	65	--	25	5	30
26	584	5	170	80	--	15	50	125
33	101	70	155	60	--	50	60	190
34	242	30	55	35	--	25	40	60
35	322	120	195	25	--	35	175	45
50	393	105	115	60	--	35	180	100
51	111	45	30	50	--	35	20	80
53	121	15	15	20	--	15	10	15
54	201	15	30	0	--	20	30	40
55	262	20	145	5	--	10	80	50
56	363	270	560	170	--	130	95	185
57	201	180	330	170	--	135	105	215
121	121	170	110	80	--	50	70	25
122	0	0	0	0	--	0	5	15
123	20	0	0	0	--	0	5	20
124	20	25	15	0	--	0	15	20
125	0	0	10	0	--	15	20	15
126	0	0	5	0	--	0	5	5
127	252	0	15	0	--	0	15	20
128	50	0	15	30	--	5	20	40
147	101	5	30	15	--	10	35	90
148	50	5	10	5	--	5	10	30
149	111	0	5	0	--	5	5	25
150	10	5	0	0	--	5	0	10
151	0	0	0	0	--	0	0	5
152	30	0	10	0	--	0	5	30
161	10	0	20	15	--	5	15	35
162	232	30	30	20	--	35	35	25
165	30	60	60	60	--	25	5	30
172	141	90	115	65	--	60	55	45
182	50	30	5	10	--	20	20	40
183	40	0	65	5	--	10	45	0
200	222	25	100	20	--	40	70	95
201	332	20	830	0	--	60	115	150
202	796	75	725	15	--	55	315	215
203	70	65	100	65	--	30	65	40
204	50	20	30	30	--	20	25	70
205	141	10	35	20	--	10	5	60
206	81	15	55	25	--	15	15	50
207	60	0	30	0	--	30	20	30

TITLE: Monitoring of the 1980 Burn Transects

INVESTIGATORS: Kristina Timmerman, Wildlife Technician, BLM
Jay Weaver, Biological Technician, Boise State University
Anne Herndon, Range Technician, BLM

COOPERATOR: Boise State University

OBJECTIVE: To investigate plant succession in post-burn sagebrush communities.

INTRODUCTION

The Swan Falls and Rattlesnake 1980 burn and control transects were established in 1981 to monitor the long-term effects of fires on the vegetation of the burned areas and to monitor the vegetation on comparable adjacent unburned plant communities. Both fires occurred in 1980 in big sagebrush (Artemisia tridentata) habitat. Another fire burned the Rattlesnake Control transect in August, 1983. The same fire re-burned the Rattlesnake Burn transect.

METHODS

Four vegetation canopy coverage transects (Daubenmire 1959) were established on each of the 2 sites in 1981. At each burn site, a control transect was set up in native vegetation. In addition, a parallel transect was set up within the adjacent burn. Each transect consisted of 40 1-m^2 plots, 10 m apart on a transect line 400-m long. The lower right corner of each 1-m^2 plot was located by a numbered (1-40) wooden stake. These plots were permanently remarked with curved rebar stakes in 1988. The percent canopy coverage of each plant species present on each transect was estimated and recorded. Data were collected in May and June.

Fifteen shrub density plots were established (Asherin 1973) on each of the unburned transects in 1981. Plots were located on the line transects used in canopy coverage sampling. Density plots were circular, and size was either 0.004 ha or 0.010 ha (1/100 acre or 1/300 acre) depending on the year sampled. A cord 203 cm or 353 cm (6'8" or 11'7") in length was staked to the ground at the center of the circle. The sampling technician used the cord as the radius of a circle which defined the area to be sampled. All shrubs rooted within the area of the circle were counted and recorded. Shrub density samples were taken every 15 m. Data were collected in May, June, and September.

SAMPLING HISTORY

Transects were sampled annually from 1981-84 and 1987-88 for canopy cover. Density was also sampled in the same years except 1987. Data are on file in the Snake River Birds of Prey Research office. Raw data are available by year in the 1980 "Burn Transects; Field Data Sheets" file for

years 1981, 1982, 1987, and 1988 for cover and years 1981, 1982, and 1988 for density (Table 1). Data summary sheets are available by year in the "1980 Burn Transect" file for years 1981-83 and 1987-88 for cover and for years 1981-83 and 1988 for density (Table 1).

The larger plot size (0.01 ha) was used in 1981, 1982, and 1988. The smaller plot size (0.004 ha) was used in 1983, 1984, and 1988.

RESULTS

Swan Falls Control

Shrub Density. In 1981, shrub density was 8862.6 shrubs/ha on the Swan Falls Control transect. In 1982, density had increased to 9817.3 shrubs/ha. Another increase, to 17214.6 shrubs/ha was recorded in 1983. Density data for 1984 are missing. Density data were not collected in 1987 (Table 2).

In 1988 both 0.01 ha plots and 0.004 ha plots were sampled on the Swan Falls Control transect. The 0.004 ha plot sampling estimated the average shrub density at 18607.0 shrubs.ha (Table 2). The 0.01 ha plot sampling estimated the average shrub density at 11609.0 shrubs/ha (Table 2). The estimated mean number of shrubs/ha on the 2 plot sizes differed significantly (t = 5.642036, df = 14, P = 6.073713-^{05}).

Canopy Cover. The mean percent canopy cover of *Artemisia tridentata* increased from 26.7% in 1981 to 32.5% in 1982. Canopy cover of *A. tridentata* declined in 1983, 1987, and 1988 (Table 3).

Relative to *A. tridentata* canopy cover, *Bromus tectorum* was present in low amounts on this transect in all years sampled. No change was recorded in mean percent canopy cover between 1981-1982 (0.1%). In 1983, canopy cover of *B. tectorum* increased to 0.2%. In 1987, *B. tectorum* increased by 500% and again by 50% in 1988. *B. tectorum* was at its highest mean canopy cover on this transect in 1988, 1.8% (Table 3). On the control transect, *B. tectorum* never provided more than 8.0% of the mean total canopy cover in any year.

Mean percent cover of *Festuca octoflora* remained almost constant between 1981 and 1982 (19.3% and 19.7%). In 1983, the amount of *F. octoflora* declined to 8.9%. *F. octoflora* declined further in 1987 and 1988, dropping to 3.9% and 0.5%, respectively (Table 3).

Mean canopy cover of *Poa sandbergii* declined between 1981 and 1982, from 2.1% to 1.5%. *P. sandbergii* increased by 193% in 1983. In 1987, *P. sandbergii* increased over 1983 levels by 77%. In 1988, a decrease to 5.6% mean canopy cover was recorded (Table 3). The canopy cover of 5.6% in 1988 was more than 2 times the level of *P. sandbergii* recorded in 1981.

Other plant species present on the transect were *Sitanion hystrix*, *Descurania pinnata*, *Elymus cinereus*, *Stipa thurberiana*, and other unidentified forbs (Table 3). Other unidentified forbs were usually present in trace amounts (less than 0.04%) except for 1983, when a 10.3% cover was recorded (Table 3).

Table 1. Sampling history (1981-1988) and data locations for the 1980 Burn Transects, southern Ada and Elmore Counties, Idaho. Sampling was not done in 1985 and 1986. N = not sampled, NL = sampled, data not located, L = data located (4 transects).

Rattlesnake Burn

	Canopy Cover						Shrub Density					
Years Sampled	1981	1982	1983	1984	1987	1988	1981	1982	1983	1984	1987	1988
Date Sampled	6/19	6/01	5/24	?	6/09	5/25	6/19	6/01	5/24	?	N	6/13
Raw Data	L	L	NL	NL	L	L	L	L	NL	NL	N	L
Data Summaries	L	L	L	NL	L	L	L	L	L	NL	N	L

Swan Falls Burn

	Canopy Cover						Shrub Density					
Years Sampled	1981	1982	1983	1984	1987	1988	1981	1982	1983	1984	1987	1988
Date Sampled	6/18	6/02	5/25	?	6/03	5/25	6/18	6/02	5/25	?	N	6/13 9/13
Raw Data	L	L	NL	NL	L	L	L	L	NL	NL	N	L
Data Summaries	L	L	L	NL	L	L	L	L	L	NL	N	L

Table 2. Average shrub density on the Rattlesnake and Swan Falls Burn Transects, 1981-1988 (4 transects).

Plant Species	Av. Density (#/ha)				
	1981	1982	1983	1984	1988
RATTLESNAKE BURN					
Artemisia tridentata	82.4[1]	130.9[1]	164.7[2]	*	--
Chrysothamnus nauseosus	16.5[1]	17.3[1]	12.5[2]	*	--
RATTLESNAKE CONTROL					
Artemisia tridentata	8006.0[1]	10328.8[1]	14694.2[2]	*	--
SWAN FALLS BURN	no shrubs present				
SWAN FALLS CONTROL					
Artemisia tridentata	8862.6[1]	9817.3[1]	17214.6[2]	*	11609.0[1] 18607.0[2]

* = sampled; data not located
-- = no shrubs present
[1] = 0.01 ha plot
[2] = 0.004 ha plot

Table 3. Mean percent canopy cover in a big sagebrush habitat, 1981-1988. (1 transect).

Plant Species	Swan Falls Control Transect				
	1981	1982	1983	1987	1988
Artemisia tridentata	26.7	32.5	35.1	19.5	14.1
Bromus tectorum	0.1	0.1	0.2	1.2	1.8
Festuca octoflora	19.3	19.7	8.9	3.9	0.5
Poa sandbergii	2.1	1.5	4.4	7.8	5.6
Sitanion hystrix	1.3	1.2	1.3	1.0	0.1
Descurainia pinnata	0.6	0.2	1.7	--	0.2
Elymus cinereus	0.2	0.2	0.3	--	--
Stipa thurberiana	0.1	--	0.1	1.0	--
Other forbs	trace	1.2	10.3	--	0.3
Mean total cover	50.4	56.5	62.4	34.5	22.5
Bare ground	75.9	68.4	77.7	90.7	94.2

trace = plant species present in amounts $\leq$ 0.04%

In 1981, mean total plant cover was 50.4%. In 1982, total cover increased to 56.5%. Cover increased again in 1983, to 62.4%. In 1987 and 1988, cover decreased to 34.5% and 22.5% respectively (Table 3).

Swan Falls Burn

Shrub Density. No shrubs have been recorded on the Swan Falls Burn transect in any sampling year (Table 2).

Canopy Cover. All *A. tridentata* shrubs were killed by the 1980 burn, and no seedlings were detected on this transect in any year sampled (Table 4). No *B. tectorum* was detected the transect in 1981, 1982, or 1983. *B. tectorum* was present on the transect in 1987, occurring as 16.0% mean percent canopy cover. In 1988, a decline of 34% from the 1987 level (10.5%) was recorded (Table 4).

In 1981, *F. octoflora* had a mean percent canopy cover of 9.1%. In 1982 *F. octoflora* showed an increase to 18.0%. Mean canopy cover in 1983 was 30.0%. In 1987, the mean percent canopy cover had declined from the 1983 levels to 3.4%. *F. octoflora* declined to 0.3% in 1988. (Table 4).

P. sandbergii increased in mean percent canopy cover each year that data were collected between 1982-1987. Respectively, canopy cover was 4.5%, 9.4%, and 13.0%. In 1988, *P. sandbergii* decreased, to 12.1% cover (Table 4).

In 1981, the mean percent canopy cover of *Sisymbrium altissimum* was 0.1%. In 1982, canopy cover was 10.2%. Canopy cover of *S. altissimum* increased again in 1983, to 20.1%. A decline was recorded in 1987 and 1988, to 1.8% and 1.6% respectively (Table 4).

Mean percent canopy cover of *Descurania pinnata* on the transect was 3.6% in 1981. *D. pinnata* increased to 4.2% in 1982. In 1983, *D. pinnata* percent cover (0.4%) dropped below the 1981 level. *D. pinnata* was not recorded on the transect in 1987. In 1988, a mean percent canopy cover of 2.3% was recorded (Table 4).

In 1981, the first post-burn growing season, total percent canopy cover was 17.6%. In 1982, cover increased to 38.7%. Again in 1983, cover increased to 64.5%. In 1987 and 1988, total mean percent canopy cover decreased each year, to 34.2% and 28.4% respectively (Table 4).

Rattlesnake Control

Shrub Density. Shrub density increased from 8006.0 shrubs/ha in 1981 to 10328.8 shrubs/ha in 1982. In 1983, shrub density increased to 14696.2 shrubs/ha. A fire in 1983 destroyed all shrubs. As of 1988 no new seedlings had been recorded or observed on the transect (Table 2).

Canopy Cover. Mean percent canopy cover of *A. tridentata* shrubs on the Rattlesnake Control transect was lower than on the Swan Falls Control transect in 1981, 1982, and 1983. All shrubs were killed by the August 1983 fire, and the area has not been re-invaded as of 1988.

Table 4. Mean canopy cover in a burned big sagebrush habitat, 1981-1988. Transect burned in 1980 (1 transect).

Plant Species	Swan Falls Burn Transect				
	1981	1982	1983	1987	1988
Artemisia tridentata	--	--	--	--	--
Bromus tectorum	--	--	--	16.0	10.5
Festuca octoflora	9.1	18.0	30.0	3.4	0.3
Poa sandbergii	3.2	4.5	9.4	13.1	12.1
Sitanion hystrix	--	trace	--	trace	0.1
Descurainia pinnata	3.6	4.2	0.4	--	2.3
Sisymbrium altissimum	0.1	10.2	20.1	1.8	1.6
Salsola kali	0.5	trace	trace	--	0.3
Elymus cinereus	0.9	1.2	1.2	--	--
Lepidium perfoliatum	--	0.3	2.3	0.7	1.1
Lactuca serriola	--	--	--	trace	--
Other forbs	0.1	0.2	1.0	--	0.2
Mean total cover	17.6	38.7	64.5	34.2	28.4
Bare ground	88.5	73.6	59.8	79.0	87.6

trace = plant species present in amounts $\leq$ 0.04%

Between 1981 and 1983, A. tridentata on the transect fluctuated each year. In 1981, mean percent canopy cover was 7.1%. In 1982, cover increased to 9.4%. In 1983, cover declined from the 1982 levels to 8.6%. All A. tridentata on the transect were killed in the 1983 burn (Table 5).

B. tectorum had the highest mean percent canopy cover in all years sampled on the Rattlesnake Control transect (as compared to all other species present). In 1981, canopy cover was 29.2%. Canopy cover in 1982 increased to 42.7%. In 1983, B. tectorum increased to 66.2% cover (Table 5).

In 1981, mean total canopy cover was 37.9%. In 1982, cover increased to 54.9%. Cover increased again in 1983, to 76.4%. Declines in canopy cover were recorded in both 1987 and 1988. (Table 5).

All other plant species on the transect comprised less than 0.05% of the total cover in any year between 1981-1988. Other species present were F. octoflora, P. sandbergii, S. hystrix. D. pinnata, S. altissimum, Salsola kali, and other unidentified forbs (Table 5).

Rattlesnake Burn

Shrub Density. Both A. tridentata and Chrysothamnus nauseosus were present on the shrub density plots, even though none were recorded on any of the canopy coverage plots. This transect re-burned in 1983 and all remaining shrubs were destroyed.

In 1982, density of A. tridentata increased from 82.4 shrubs/ha to 130.9 shrubs/ha (Table 2). Another increase was recorded in 1983, when 164.7 shrubs/ha were recorded. In 1981, C. nauseosus was present in much lower densities relative to A. tridentata, only 16.5 shrubs/ha. In 1982, a slight increase to 17.3 shrubs/ha was recorded. In 1983, densities of C. nauseosus declined to 12.5 shrubs/ha. Loss of all shrubs from a 1983 burn on the Rattlesnake Burn transect prevented any shrub density sampling in 1984, 1987, and 1988. A visual search was run at the transect to determine if any shrubs were present.

Canopy Cover. Of all plant species present on the Rattlesnake Burn transect, B. tectorum had the highest mean percent canopy cover in all years sampled. In 1981, canopy cover was 28.6%. In 1982, canopy cover increased to 52.2%. Another increase was recorded in 1983, when canopy cover reached 74.4% (Table 6). In 1981, mean total percent canopy cover was 30.0%. In 1982, cover increased to 53.6% (Table 6). Cover increased again in 1983, but decreased in 1987. All other plant species present on the transect in 1981-1988 comprised less than 0.05% of the total cover in any year. Other species present were F. octoflora, P. sandbergii, S. hystrix, D. pinnata, S. altissimum, Lomatium dissectum, S. kali, and other unidentified forbs (Table 6).

Table 5. Mean percent canopy cover in big sagebrush habitat, 1981-1988. Transect burned in 1983 (1 transect).

Plant Species	Rattlesnake Control Transect				
	1981	1982	1983	1987	1988
Artemisia tridentata	7.1	9.4	8.6	--	--
Bromus tectorum	29.2	42.7	66.2	39.5	33.4
Festuca octoflora	--	--	0.4	0.5	--
Poa sandbergii	0.8	1.6	0.9	4.0	1.5
Sitanion hystrix	0.5	1.0	0.2	0.1	0.1
Descurainia pinnata	trace	0.1	--	--	1.8
Sisymbrium altissimum	0.3	0.1	--	0.1	--
Salsola kali	--	--	--	0.1	0.5
Other forbs	trace	0.1	trace	--	--
Mean total cover	37.9	54.9	76.4	43.1	36.4
Bare ground	74.6	67.1	50.7	73.1	89.5

trace = plant species present in amounts ≤ 0.04%

Table 6. Mean percent canopy cover in a burned big sagebrush habitat, 1981-1988. Transect burned in 1980 and 1983 (1 transect).

Plant Species	Rattlesnake Burn Transect				
	1981	1982	1983	1987	1988
Artemisia tridentata	--	--	--	--	--
Bromus tectorum	28.6	52.2	74.4	44.3	43.4
Festuca octoflora	--	--	0.1	trace	--
Poa sandbergii	0.3	0.5	0.3	2.2	1.6
Sitanion hystrix	0.1	0.1	0.1	0.1	0.1
Desurainia pinnata	--	trace	--	--	2.1
Sisymbrium altissimum	0.1	0.4	1.0	0.2	--
Lomatium dissectum	0.4	--	--	--	--
Salsola kali	0.6	--	--	0.3	--
Other forbs	--	0.5	0.1	--	--
Mean total cover	30.0	53.6	75.9	44.8	47.2
Bare ground	76.4	61.2	39.4	69.3	85.4

trace = plant speces present in amounts ≤ 0.04%

DISCUSSION

Big Sagebrush is highly susceptible to fire injury (Bunting 1985, West and Hassan 1985, Zschaechner 1985). If exposed to a minimum of 90 C for a minimum period of 30 sec, most sagebrush will be killed (Britton and Clark 1985). Re-establishment of big sagebrush occurs only through seed germination. It will not sprout from the roots or crown after a fire as will other shrubs (Blaisdell 1953).

After a fire, shrub seedling re-establishment can occur at different rates. In a Nevada study, seedling re-establishment occurred in the 3rd and 4th post-burn year (Zschaechner 1985). In a study on the Upper Snake River Plains, only a 10% return of sagebrush was recorded 12 years after a fire (Blaisdell 1953).

On the Swan Falls Burn transect, all big sagebrush plants were eliminated by fire in 1980. In 8 years since this fire, no sagebrush seedlings have been recorded. On the Rattlesnake Burn transect, shrubs were not completely eliminated in the 1980 fire (Table 2). When this transect re-burned in 1983, all remaining shrubs were eliminated. No sagebrush seedlings have been recorded in the 5 years since this fire.

Factors affecting sagebrush re-establishment are the amount of viable seed remaining after the fire, distance to an unburned seed source, the timing and amount of precipitation following the fire, and the season of the burn (Britton and Clark 1985, Zschaechner 1985).

The viability of seed remaining on the transects after the fire is unknown. The Swan Falls Burn transect is 25 m from a robust stand of big sagebrush. The Rattlesnake Burn transect was 30 m from a big sagebrush stand until a 1983 fire destroyed all shrubs. Blaisdell (1953) found a negative correlation between the number of sagebrush plants and the distance from a seed source. Both burn transects were close to a seed source in the first 3 years after the fire, yet neither had any sagebrush seedling establishment. Factors other than seed source may be influencing seedling re-establishment.

Annual precipitation on the SRBOPA is 20 cm (U.S. Dept. Inter. 1979). Most precipitation falls between November and April. Precipitation during this time period is critical for the growth of annual grasses and sagebrush establishment (U.S. Dept. Inter. 1979, Britton and Clark 1986). Timing, amount, and pattern of precipitation the first year after a fire can determine plant succession (Britton and Clark 1986). Precipitation between November and April near the Swan Falls Burn transect was 19 cm, 22 cm, and 22 cm (Kuna Weather Station) for respective seasons after the 1980 fire. This is near or above the annual precipitation in the SRBOPA. Precipitation between November and April near the Rattlesnake transects was higher than the annual precipitation in the SRBOPA for each season after the 1980 fire (Mountain Home Weather Station, 21 cm, 22 cm, and 23 cm respectively). Precipitation for 3 years after the fire probably did not limit the re-establishment of sagebrush seedlings. Precipitation after 1986 has been lower than average and may have prevented any shrubs from sprouting during that time.

In addition, grazing may affect the re-establishment of sagebrush. The Swan Falls transects and the Rattlesnake Burn transect are grazed in the spring/fall, and the Rattlesnake Control transect is grazed in the winter.

Fisser (1986) found that sites protected from grazing had better shrub growth when compared to sites that were grazed.

The total cover of annuals and perennials on the Swan Falls Burn transect had increased to almost the same level as the Swan Falls Control transect in the 1st year after the burn (1981). By 1982, annual and perennial cover on the burn transect had increased by 61% over the annual and perennial cover on the control transect. An increase in production of perennial grasses in the first 3 years after a burn has been attributed to the release from competition by _A_. _tridentata_ (Bunting 1985).

In the first 3 years after the burn _F_. _octoflora_ and _P_. _sandbergii_ (native perennials) provided 63.8%, 58.2%, and 61.0% of the total cover on the Swan Falls Burn transect. In 1987, _B_. _tectorum_ was recorded as 16.0% on the Swan Falls Burn transect. This was 46% of the total cover. _B_. _tectorum_ was not recorded on the Swan Falls Control transect between 1980 and 1983. It probably was not present as a large percentage in the understory of the Swan Falls Burn transect prior to the 1980 fire. The lag in appearance of _B_. _tectorum_ on the burn transect may be a result of a small seed source and other factors not yet determined.

Bunting (1985) states that annual plants such as _B_. _tectorum_ can re-invade disturbed areas formerly occupied by _A_. _tridentata_ if perennials are not present in the shrub understory. _F_. _octoflora_ appeared to be well established by 1983 and then declined to low levels in 1987 and 1988. Both of these years had low amounts of precipitation and may have influenced the decline.

The total cover of annuals and perennials on the Rattlesnake Burn transect had increased to within 3% of the amount on the Rattlesnake Control transect in 1981. In 1982, cover of grass and forbs on the burn transect had increased 18% over the forbs and grass cover on the control transect.

_B_. _tectorum_ provided more than 75% of the total cover on the Rattlesnake Control transect and more than 94% of the total cover on the burn transect in all years sampled. _B_. _tectorum_ was present at higher levels on the Rattlesnake control transect than on the Swan Falls control transect. Also _B_. _tectorum_ was higher on the Rattlesnake Burn transect than on the Swan Falls Burn transect. A seed source prior to a burn appears to be a factor in the establishment of the _B_. _tectorum_ immediately after a fire (Bunting 1985).

Problems

In reviewing the 1980 Burn transect data, several problems have been identified.

First, estimated shrub density has varied from year to year. At least part of this variation is due to a plot size change in 1983 (Table 2). Comparisons showed that plot size can significantly affect estimates of shrub density. The smaller plots may overestimate the number of shrubs. In addition, inexact plot locations may also influence shrub density estimates each year. Cattle and sheep kick out the plot markers (wooden lathes) each season. The wooden lathes are set back in the ground by the field staff each

season. There is no guarantee that the sampling points are exactly the same from year to year.

Finally, a sample size of 15 plots may not large enough to determine if increases or decreases in shrub density are real or are a result of observer variability (Anderson, pers. commun.). In addition, 4 transects may be insufficient for reliably comparing trends among sites.

Recommendations

The transects should be monitored until factors influencing the re-establishment of sagebrush are clarified. Use of the larger plot size (0.01 ha) should be continued. Additional transects would provided a wider sample of the SRBOPA, and would increase the sample size. If additional transects are established, pre-burn vegetation data should be collected.

The beginning and end of each Daubenmire transect (plot #1 and plot #40) were permanently marked with fence posts in 1988. The remaining plots are still marked with wooden lathes. These should be replaced with a permanent markers in 1989.

ACKNOWLEDGMENTS

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TITLE: Effects of Fire on Soil Microbial Communities

INVESTIGATORS: Marcia Wicklow-Howard, Dept. of Biology, Boise State University
Robert Rychert, Dept. of Biology, Boise State University

COOPERATOR: Boise State University

INTRODUCTION

In the Snake River Birds of Prey Area (SRBOPA), massive losses of shrubsteppe habitat by fire may be threatening the stability of one of the world's most unique collections of nesting raptors. Preliminary research on the immediate impacts of fire on this vegetation-prey base-raptor relationship was multifaceted. Included in the study was an investigation of effects of fire on soil microbial communities. The partial results of the microbial ecology component of the project are presented here.

ANNUAL REPORT

Microbial Activity

Study sites were established within the SRBOPA, Idaho. Sites were characterized as burned and unburned sagebrush, and as burned and unburned winterfat. The unburned sagebrush site is dominated by big sage and cheatgrass (*Bromus tectorum* L.). Root and soil samples were taken from these sites immediately following the burns in August 1987 and then from April to June 1988. A September 1988 sample is yet to be analyzed.

The sagebrush burn site exhibited reduced microbial activity and biomass-C (August 1987) when compared with the unburned site (Tables 1 and 2). The converse was true for the winterfat site. However when dehydrogenase activity per unit biomass-C was compared for burned and unburned sites, the differences between activity and biomass on burned and unburned sites were not pronounced (Table 3). By June 1988, the activity per unit biomass for the unburned sites was not significantly greater than the burned sites.

In terms of overall microbial activity and biomass, spring rainfall readily lends to a restoration of any lost microbial activity and biomass following an intense summer rangeland fire.

Soil Mineral Nitrogen

The soil mineral nitrogen status did exhibit pronounced differences on burned versus unburned plots on both the sagebrush and winterfat sites. While soils were analyzed for pH, organic carbon, total P, total N, and soluble P, only the NH_4^+-N and NO_3^--N values were different on burned versus unburned plots. The soil mineral nitrogen values are listed in Table 4. These preliminary results would suggest that the major impact of

Table 1. Soil Dehydrogenase Activity.

SITE	ug TPF $gram^{-1}$ soil AUG 87	APR 88	MAY 88	JUN 88
Sagebrush-burned	1.75 ± 0.82	11.72 ± 1.39	9.20 ± 0.57	9.82 ± 0.63
Sagebrush-unburned	6.73 ± 0.81	14.71 ± 0.92	9.53 ± 2.80	8.45 ± 1.50
Winterfat-burned	11.58 ± 1.57	23.09 ± 2.71	13.89 ± 3.15	12.21 ± 1.80
Winterfat-unburned	4.40 ± 1.05	30.15 ± 0.076	7.01 ± 1.37	18.73 ± 3.37

Table 2. Soil Biomass (Carbon).

SITE	ug CO_2-C $gram^{-1}$ soil AUG 87	APR 88	MAY 88	JUN 88
Sagebrush-burned	541 ± 42	1973 ± 110	1331 ± 281	986 ± 90
Sagebrush-unburned	1165 ± 102	2775 ± 266	519 ± 18	684 ± 198
Winterfat-burned	832 ± 75	1965 ± 552	1073 ± 327	728 ± 143
Winterfat-unburned	580 ± 62	2434 ± 478	375 ± 126	1065 ± 162

Table 3. Dehydrogenase Activity per unit of Biomass-C.

SITE	AUG 87	APR 88	MAY 88	JUN 88
	(ug TPF/ug CO_2-C) x 10^3			
Sagebrush-burned	3.23	5.94	6.91	9.96
Sagebrush-unburned	5.78	5.30	18.36	12.35
Winterfat-burned	13.92	11.75	12.94	16.77
Winterfat-unburned	7.59	12.39	18.69	17.59

Table 4. Soil Mineral Nitrogen Status.

SITE	DATE	NH_4^+-N	NO_3^--N
		ug. gram^{-1} soil	
Sagebrush-burned	AUG 87	4.49	4.70
	APR 88	0.10	32.00
	MAY 88	0.05	18.90
	JUN 88	< 0.01	27.20
Sagebrush-unburned	AUG 87	0.90	4.90
	APR 88	0.39	17.60
	MAY 88	0.64	1.20
	JUN 88	0.23	7.50
Winterfat-burned	AUG 87	2.07	6.90
	APR 88	0.24	27.60
	MAY 88	0.08	14.60
	JUN 88	< 0.01	13.50
Winterfat-unburned	AUG 87	0.83	5.40
	APR 88	0.11	13.20
	MAY 88	< 0.01	3.00
	JUN 88	3.76	29.60

rangeland fires on soil microorganism and their activities is reflected in major effects on the nitrogen cycle. Fire appears to enhance mineralization of nitrogen initially, and subsequently there is an increase in the soil NO_3^--N. The latter may be due to enhanced nitrification or reduced nitrification Since biomass-C differences are not very great, the data suggest an enhancement of nitrification. It would be useful to know the population of nitrifying bacteria.

Mycorrhizal Root Infection

Roots were microscopically examined for the presence of mycorrhizal infection, and quantified to obtain percent root area infected. Results of root infection are presented in Table 5. In the unburned sagebrush study site, it appears that big sage had a greater mycorrhizal infection at all samplings, as compared to cheatgrass and the unidentified grass species. Additionally, the mycorrhizal infection appeared to increase from a low of 47% in April to a high of 80% in May. On the burned site, little root infection was noted for early spring on any of the plants initially colonizing the area. Generally, plants colonizing the sites the first year following a burn do not form mycorrhizal root infections. Species such as *Salsola kali* L. (Russian thistle) and cheatgrass appear to have little mycorrhizal dependence, and can colonize area lacking mycorrhizal propagules. Table 6 demonstrates changes in mycorrhizal spore numbers from April through June 1988. On the winterfat site, spore numbers increased some during this period of time. Winterfat does not normally form mycorrhizae even when propagules are available. This is noted by comparing the data presented in both Table 5 and 6. In contrast, the unburned sagebrush sites showed a decrease in spore numbers in the soil, as mycorrhizal root infections increased throughout the summer.

Table 5. Percent mycorrhizal root infection. Number of samples are indicated in parentheses.

Plant Species	Study Site: Sagebrush Burned	Sagebrush Unburned	Winterfat Burned	Winterfat Unburned
Winterfat (*Ceratoides lanata*)				
AUG 87	--	--		(2) 0%
APR 88	--	--	--	(10) 0%
MAY 88	--	--	--	(10) 0%
JUN 88	--	--	--	(10) < 0.1%
Big Sagebrush (*Artemisia tridentata* var. *wyomingensis*)				
AUG 87	--	(2) 71.5%	--	--
APR 88	--	(10) 47%	--	--
MAY 88	--	(8) 80%	--	--
JUN 88	--	(8) 59%	--	--
Cheatgrass (*Bromus tectorum*)				
MAY 88	--	(2) 34%	--	--
JUN 88	(6) 1.5%	(9) 21%	--	--
Squirrel Tail (*Sitanion hystrix*)				
AUG 87	--	(1) 0%	--	--
JUN 88	(2) 21%	(1) 10%	--	--
Unidentified Grass Species				
AUG 87	--	(2) 88%	--	--
APR 88	(9) 4%	(10) 16%	(8) 0.1%	(10) 0%
MAY 88	(11) 14%	(9) 29%	(9) 3%	(11) < 0.1%
JUN 88	--	--	(8) 0.4%	(10) 0%

Table 5. (cont.) Percent mycorrhizal root infection. Number of samples are indicated in parentheses.

Plant Species	Study Site: Sagebrush Burned	Sagebrush Unburned	Winterfat Burned	Winterfat Unburned
Russian Thistle (*Salsola kali*)				
MAY 88	(1) 0%	--	--	--
JUN 88	(1) 0%	--	(5) 0%	--
Mustard (*Descurainia pinnata*)				
JUN 88	(1) 0%	--	(1) 0%	--
Prickly lettuce (*Lactuca serriola*)				
JUN 88	(1) 30%	--	--	--
Onion (*Allium* sp.)				
APR 88	(1) 6%	--	--	--
Burr Buttercup (*Ranunculus testiculatus*)				
APR 88	--	--	--	(1) 0%

Table 6. Mycorrhizal spores in soil.

	#/100 grams dry weight		
Study Site	APR 88	MAY 88	JUN 88
Sagebrush-burned	26	15	14
Sagebrush-unburned	34	50	10
Winterfat-burned	59	70	67
Winterfat-unburned	0	28	37

TITLE: An Evaluation of Selected Greenstripping and Winterfat Seeding Projects in the Snake River Birds of Prey Area.

INVESTIGATORS: Steve Monsen, Botanist, USFS Shrub Sciences Lab
Mike Pellant, Greenstripping Specialist, BLM (ISO)

COOPERATOR: USFS Intermountain Research Station, Shrub Sciences Lab, Provo, UT.

OBJECTIVES:

1. Determine the establishment and recruitment of winterfat on 3 reseeding projects.

2. Evaluate the effectiveness of a disk chain in reducing cheatgrass competition and planting fire resistant vegetation (greenstrips).

INTRODUCTION

The impacts of wildfires on prey habitat in the Snake River Birds of Prey Area (SRBOPA) is of great concern to resource managers (Kochert and Pellant 1986). The BLM initiated a shrub restoration program in the SRBOPA in 1982 by reseeding winterfat (Ceratoides lanata) and perennial grasses on a portion of a 10,664-ha wildfire.

Hydroseeding was used to distribute winterfat seed on the Kuna/Coyote and Melba rehabilitation projects (Table 1). This technique was effective in distributing the light and fluffy seed of winterfat but was labor intensive, thus very costly (Pellant and Reichert 1983). Since 1984, winterfat seed has been pelleted with inert clay and aerially seeded. The Trio rehabilitation project was treated in this manner. By using pelleted seed, winterfat can be economically seeded over large acreages.

In 1984 Idaho BLM initiated a wildfire pre-suppression program, termed "greenstripping" to reduce the size and frequency of wildfires in southern Idaho. Greenstripping involves the seeding of strips of fire resistant vegetation at strategic locations to slow or stop the spread of wildfires.

The first greenstripping project completed in the SRBOPA was done in 1985 south of Mountain Home, ID. Various disking and blading techniques have been used to reduce the competition of alien annual species, primarily cheatgrass (Bromus tectorum), prior to seeding greenstrips.

In 1986 a disk chain was used to seed a greenstrip in the Swan Falls area. The disk chain consists of 2 lengths of anchor chain with disks and a roller bar with elevated seed boxes (Fig. 1). The disk chain is cost effective since only one pass is needed for seedbed preparation and seeding. However, the effectiveness of this unit in producing a suitable seedbed for perennial plant establishment has not been fully documented.

Table 1. Description of winterfat study sites and seeding procedures.

Variables	Study Sites		
	Melba	Kuna/Coyote	Trio
Study Location	T. 1 S., R. 1 W., Sec 15	T. 1 S., R 1 W., Sec 27	T. 1 S., R. 1 W., Sec. 29
Date of Burn	8/20/82	9/19/81	7/12/85
Date Seeded	3/83	11/82	3/86
Seeding Techniques	Hydroseed & Harrow	Hydroseed-shrub Aerial seed-grass & harrow	Aerial seed* shrub & drill seed grass
Seeding Rates (PLS**kg/ha):			
Grasses	1.4	2.4	2.8
Winterfat	0.14	0.69	0.22

* Pelleted winterfat seed.
** PLS = Pure Live Seed.

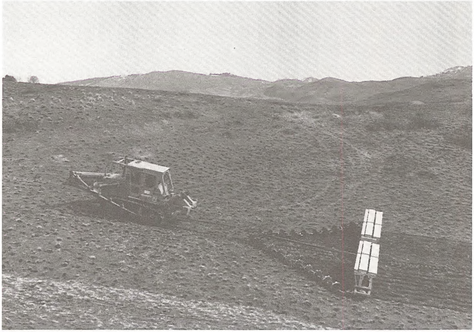

Figure 1. Disk chain being used on greenstripping project near Boise, Idaho.

In the fall of 1987, 4 greenstrips were seeded in the SRBOPA with the disk chain. Two of these projects (White Sage and Crater II) were evaluated in July, 1988. White Sage is located 2 km south of Kuna Butte (T. 1 N., R. 1 W., Sec. 28) and Crater II is 0.9 km north of Crater Rings (T. 3 S., R. 5 E., Sec. 34).

METHODS

Winterfat Studies

Ten 6 x 6 m plots were randomly selected and permanently marked at each study site. At the Melba study site, separate studies were established in pre-fire winterfat and Wyoming big sagebrush (Artemisia tridentata) sites. The pre-fire plant communities at the Kuna/Coyote and Trio sites were dominated by winterfat with small islands of big sagebrush.

In each 6 x 6 m plot, density of winterfat was recorded and height and crown diameter of 4 randomly selected plants measured. A 1-m frame was centered over each selected winterfat plant and frequency, density and ground cover and litter recorded for all plants occurring in the plot.

Recruitment was determined by counting the number of winterfat seedlings in a 0.5 x 1.0 m frame positioned at the base of the 4 previously selected winterfat plants. The percent cover of other species and litter was also recorded within this frame to determine if the location of winterfat seedlings was correlated with existing vegetation or litter.

Data were analyzed by comparing means with the Students t test.

Greenstrip Studies

Two greenstrip projects were selected and evaluated in July 1988. Treatments evaluated at each project included:

	Crater II Treatments	White Sage Treatments
1.	Disk chain in burned cheatgrass.	Disk chain in burned sagebrush.
2.	Disk chain in unburned cheatgrass.	Disk chain in unburned sagebrush.
3.	Rangeland drill in burned big sagebrush.	Aerial seed and harrow on burned sagebrush.
4.	Burned cheatgrass, no treatment.	Burned sagebrush, no treatment.
5.	Unburned cheatgrass, no treatment.	

Each treatment was evaluated by randomly establishing 5 50-m transects and reading 30 1-m² square plots per transect. Understory and seeded species were documented by recording frequency, density and cover in each plot. Shrub presence was further characterized by using the point-centered quarter technique (Cottam and Curtis 1956). The distance to the nearest shrub,

height, crown diameter and age class were recorded in 4 quarters at 10-m intervals along the 50-m transect.

RESULTS AND DISCUSSION

Greenstrip Studies

Data compilation and preliminary statistical analyses are completed on portions of the data collected last summer. Since data analysis is incomplete, no discussion of results will be included in this publication.

Winterfat Studies

Although winterfat was planted at different rates and with different methods (Table 1), satisfactory stands established at all sites (Table 2). Broadcast seeding of winterfat followed by light harrowing, or drilling grass over broadcast winterfat seed created suitable seedbeds and resulted in adequate shrub establishment.

Seeding introduced grasses, primarily crested wheatgrass (*Agropyron cristatum*), at rates between 2-6 kg/ha did not appear to affect or interfere with the establishment of planted winterfat. In addition, winterfat presence and density was not diminished by the recovery of native understory plants nor by the presence of annual weeds. Cheatgrass, although present, does not tend to dominate burned areas on the soils supporting winterfat-sagebrush mosaics in the treatment areas.

The Melba site produced the greatest number of winterfat plants (Table 2). Plantings at this location were made on areas that were dominated by winterfat or Wyoming big sagebrush prior to the burn. A significantly higher number of seeded winterfat plants established in pre-fire winterfat sites than on pre-fire sagebrush sites.

The percent of planted seeds at Melba to develop into established plants was 9.8 percent for pre-fire sagebrush sites compared to 14.6 percent for pre-fire winterfat sites. Seedling success at the Kuna/Coyote and Trio plantings were both over 2 percent. These percentages, although they seem low, represent acceptable initial establishment rates.

Planting success was likely affected by seasonal climatic conditions, however measurements of shrub density and growth were only recorded in 1988. Both the Kuna/Coyote and Melba plantings benefited from above average precipitation in 1982 (+20%) and 1983 (+42%) (Table 3). Plantings completed at the Trio site in 1986 were conducted during a year of near normal precipitation; however the precipitation received in 1987, was nearly 20% below normal. These droughty conditions and the early spring seeding date may have adversely affected winterfat establishment.

Although the seeded winterfat plants ranged from 3 to 6 years in age, all plants were of similar size and maturity when evaluated in 1988 (Table 4). Individual plants established and grew rapidly at each planting date, attaining maturity in 2 to 3 years.

Table 2. Seeding rates and plant establishment at 4 study sites.

	Melba (Winterfat)	Melba (Sagebrush)	Kuna/Coyote	Trio
No. of winterfat seeds sown/ha	21,255	21,255	103,238	32,793
Mean no. of winterfat plants attained/ha	3,138 A	2,083 A	2,194 A	944 B
% Success	14.6	9.8	2.1	2.9

Means with the same letter are not significantly different at alpha = 0.05

Table 3. Mean annual precipitation (cm) at Kuna, Idaho. Average annual precipitation is 24.8 cm.

	YEARS						
	1981	1982	1983	1984	1985	1986	1987
Amount Received	37.0	30.4	35.1	26.0	25.2	21.7	20.2
Departure Normal	+11.6	+4.9	+10.4	+1.3	+0.4	-0.5	-4.6

Table 4. Mean height and crown diameter of seeded winterfat plants at 4 study locations.

Study Site	Height (cm)	Crown (cm)
Kuna/Coyote	41.0 A	46.6 A
Melba Winterfat	45.4 A	36.9 B
Melba Sagebrush	42.9 A	35.1 B
Trio	44.2 A	32.1 B

Means with the same letter are not significantly different at alpha = 0.05.

The winterfat seed used in all plantings was collected from high elevation, central Utah locations. This ecotype is more robust and taller than local winterfat populations. Local winterfat stands rarely produce new individuals (Yensen and Smith 1984). The youngest winterfat plant found in the SRBOPA by these researchers was 22 years old. The Utah source of winterfat appears to readily reproduce and spread when climatic conditions are favorable.

Recruitment of new winterfat seedlings occurred in 1988 at all study sites (Table 5). Prior to this, few new seedlings were observed at the planting sites. New seedlings were particularly abundant at the Melba location, although numerous seedlings were recorded at both the Kuna/Coyote and Trio locations. The presence of new seedlings apparently resulted from a few important climatic events. Seeds were formed during the late summer and early winter months of 1987. Weather conditions in the spring of 1988 were favorable for winterfat seed germination and growth. Several timely rain showers occurred in April of 1988 and there were no apparent killing frosts after winterfat germination.

The presence of new winterfat seedlings was influenced more by the amount of seed produced by the mature plants than the competitive effects of understory species. Abundant seed crops resulted in numerous new seedlings regardless of the species composition or density of understory herbs.

All sites supported an understory of grasses and annual forbs, yet it was evident that areas supporting winterfat prior to burning remained void of cheatgrass since the time of the burn (Table 6). This is particularly true at the Melba location where pre-fire winterfat stands have only a trace of cheatgrass. However, both cheatgrass and summer annual weeds have invaded pre-fire sagebrush sites at Melba. The lack of annual weeds on burned winterfat sites improves the probability that seeded species will successfully establish. This is especially true for winterfat which has excellent seedling vigor.

Winterfat seedlings were not present in micro sites that were void of any cover. Apparently some vegetative cover aided in trapping seeds and enhancing seedling survival. Also, micro sites that supported the greatest understory cover also supported the greatest number of winterfat seedlings. The beneficial influence provided by the herbaceous cover is not well understood, but winterfat seedlings were able to establish amid considerable herbaceous competition.

PLANS FOR 1989

The winterfat study sites will be re-sampled in 1989 to determine survival of 1988 winterfat seedlings. After collection and analysis of 1989 data, a manuscript will be prepared for submission to the Journal of Range Management.

Greenstrip monitoring will continue during the 1989 field season on all greenstrips established in the SRBOPA. Special emphasis will be placed on evaluating greenstrips affected by the 1987-88 drought to determine if reseeding is necessary. Technical reports on findings and recommendations will be prepared by the end of 1989.

Table 5. Winterfat seedling recruitment at 4 study sites.

Study Site	Date of Planting	% Mature Shrubs With Seedlings	Mean Number of Seedlings per Mature Shrub
Melba Sagebrush	1983	50.0	2.18 A
Melba Winterfat	1983	32.5	0.66 B
Kuna/Coyote	1982	10.0	0.33 B
Trio	1986	10.0	0.10 B

Means with same letter are not significantly different alpha = 0.05.

Table 6. Percent ground cover of herbaceous species and litter at each study site.

Species	Melba Sagebrush	Melba Winterfat	Kuna/ Coyote	Trio
Cheatgrass	3.35 A	0.00 B	0.00 B	1.88 A
Russian Thistle (*Salsola kali*)	17.35 A	7.41 B	0.25 C	22.41 A
Descurainia spp.	3.33 A	0.28 B	0.00 D	0.11 C
Native Grasses	22.89 A	20.15 A	22.23 A	13.01 B
Seeded Grasses	2.83 C	2.03 C	15.29 A	6.33 B
Litter	21.18 A	21.94 A	17.13 A	2.65 B
Bare Ground	33.38 B	34.44 B	28.88 B	60.00 A

Numbers in horizontal rows with same letter are not significantly different at alpha = 0.05.

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TITLE: Effect of Seeding Date and Microsite Conditions on Seed Germination and Seedling Establishment of spiny hopsage (*Grayia spinosa* [Hook.] Moq.)

INVESTIGATORS: Nancy L. Shaw, USDA For. Serv., Intermountain Research Station
Marshall R. Haferkamp, USDA Ag. Res. Service, Ft. Keogh Livestock and Range Research Laboratory

OBJECTIVE: To examine the effects of planting date and seedbed conditions on the seed dormancy and germination and seedling establishment of spiny hopsage.

INTRODUCTION

Our earlier reseeding studies with spiny hopsage indicate that populations from the northern portion of the species natural range require a period of cold temperatures to relieve dormancy. Germination occurs in early spring shortly after the ground thaws. This study was initiated to further examine the relationships between seeding date, environmental conditions within the seed bed and seed germination and seedling establishment.

STUDY SITE

Study plots are located at the Birds of Prey Area Trio Butte Study Site (T1S, R1E, S32). Soils are Scism silt loams with a rooting zone of 25 to 50 cm. Mean annual precipitation is 22.5 cm. The study was duplicated at the Lake Bed Site in the Reynolds Creek Watershed, Owyhee County, Idaho.

METHODS

Processed utricles of spiny hopsage obtained from Sponge Springs, Malheur County, Oregon, and Reynolds Creek, Owyhee County, Idaho, (Table 1) were placed in nylon mesh bags and "planted" at the Birds of Prey and Reynolds Creek sites in late fall, winter, early spring, and late spring planting dates in 1987-88 and 1988-89. Small field plots were also seeded on each planting date. The 1987-88 plots were 1.5 by 3 m and were drill seeded at the rate of 66 PLS/linear meter. Due to seed supply limitations, 0.2 m^2 plots were used in 1988-89. These were seeded by hand broadcasting 100 PLS over the plot and covering the utricles with 0.5 cm of soil.

Five planted nylon bags of each seed source were recovered on each successive planting date (Table 2) and returned to the laboratory. Seed samples from each recovered bag and control seeds of each seed source stored in the laboratory were tested for moisture content, viability, germination rate and total germination. The difference between total germination and viability provides a measure of dormancy.

Following initial seedling emergence in early spring, seedling counts were made periodically until the onset of summer dormancy in late July or

Table 1. Seed sources planted at the Birds of Prey and Reynolds Creek site in 1987-88 and 1988-89.

Collection Site	Vegetation	Elevation (m)	Year of Collection 1987-88 Planting	1988-89 Planting
Reynolds Creek Owyhee Co., ID	*Artemisia tridentata* ssp. *wyomingensis*, *Grayia spinosa*	1220	1986	1986 1988
Sponge Springs Malheur Co., OR	*Artemisia tridentata* ssp. *wyomingensis*, *Sarcobatus vermiculatus*, *Grayia spinosa*	991	1986	1986

Table 2. Dates of field plot seeding and nylon bag "planting" at the Birds of Prey and Reynolds Creek 1987-88 and 1988-89.

Planting Date	Recovery Dates for Nylon Bags
Late fall	Winter, Early Spring, Late Spring, Early Summer
Winter	Early Spring, Late Spring, Early Summer
Early Spring	Late Spring, Early Summer
Late Spring	Early Summer

early August. Soil temperature, soil moisture, and precipitation are monitored at both sites.

RESULTS

Results will be summarized following final data collection. A few general observations are of interest. In 1988, dormancy of late fall and winter planted seeds was relieved by stratification in the field. Inadequate moisture prevented germination and emergence in the field from occurring. Seeds had apparently entered secondary dormancy by the early summer recovery date as seed viability remained high, but laboratory germination was low. Few seedlings emerged from the 1987-88 field plots in 1988, but seedlings did emerge from both the 1987-88 and 1988-89 plots in 1989 following the more favorable moisture conditions of the 1988-89 winter and early spring period. Small numbers of seedlings were also observed to emerge at both Reynolds Creek and Birds of Prey sites from plots seeded in 1986-87. This indicates that some seed can remain viable in the soil for at least two years.

Small numbers of spiny hopsage seedlings were observed within native stands of the shrub near both the Birds of Prey and Reynolds Creek planting sites. These are the first naturally establishing seedling we have observed in Idaho since this series of studies began.

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